Freight Transportation in the Soviet Union

Including Comparisons with the United States

ERNEST W. WILLIAMS, JR.

GRADUATE SCHOOL OF BUSINESS
COLUMBIA UNIVERSITY

WITH THE ASSISTANCE OF

GEORGE NOVAK AND HOLLAND HUNTER

A STUDY BY THE
NATIONAL BUREAU OF ECONOMIC RESEARCH

PUBLISHED BY
PRINCETON UNIVERSITY PRESS
PRINCETON, NEW JERSEY
1962

Copyright © 1962 by National Bureau of Economic Research

All Rights Reserved

L.C. Card No. 62-11951

The endpaper map is reprinted in adapted form by permission of the publishers from Holland Hunter, *Soviet Transportation Policy*, Cambridge, Mass.: Harvard University Press, Copyright, 1957, by The President and Fellows of Harvard College.

Printed in the United States of America

Freight Transportation in the Soviet Union

NATIONAL BUREAU OF ECONOMIC RESEARCH
NUMBER 76, GENERAL SERIES

NATIONAL BUREAU OF ECONOMIC RESEARCH
1961

OFFICERS

Harold M. Groves, *Chairman*
Arthur F. Burns, *President*
Albert J. Hettinger, Jr., *Vice President*
Murray Shields, *Treasurer*
Solomon Fabricant, *Director of Research*
Geoffrey H. Moore, *Associate Director of Research*
Hal B. Lary, *Associate Director of Research*
William J. Carson, *Executive Director*

DIRECTORS AT LARGE

Wallace J. Campbell, *Nationwide Insurance*
Erwin D. Canham, *Christian Science Monitor*
Solomon Fabricant, *New York University*
Marion B. Folsom, *Eastman Kodak Company*
Crawford H. Greenewalt, *E. I. du Pont de Nemours & Company*
Gabriel Hauge, *Manufacturers Hanover Trust Company*
A. J. Hayes, *International Association of Machinists*
Albert J. Hettinger, Jr., *Lazard Frères and Company*
H. W. Laidler, *League for Industrial Democracy*
George B. Roberts, *Larchmont, New York*
Harry Scherman, *Book-of-the-Month Club*
Boris Shishkin, *American Federation of Labor and Congress of Industrial Organizations*
George Soule, *South Kent, Connecticut*
Joseph H. Willits, *Armonk, New York*
Donald B. Woodward, *A. W. Jones and Company*
Theodore O. Yntema, *Ford Motor Company*

DIRECTORS BY UNIVERSITY APPOINTMENT

V. W. Bladen, *Toronto*
Arthur F. Burns, *Columbia*
Lester V. Chandler, *Princeton*
Melvin G. de Chazeau, *Cornell*
Frank W. Fetter, *Northwestern*
R. A. Gordon, *California*
Harold M. Groves, *Wisconsin*
Gottfried Haberler, *Harvard*
Walter W. Heller, *Minnesota*
Maurice W. Lee, *North Carolina*
Lloyd G. Reynolds, *Yale*
Theodore W. Schultz, *Chicago*
Willis J. Winn, *Pennsylvania*

DIRECTORS BY APPOINTMENT OF OTHER ORGANIZATIONS

Percival F. Brundage, *American Institute of Certified Public Accountants*
Harold G. Halcrow, *American Farm Economic Association*
Theodore V. Houser, *Committee for Economic Development*
S. H. Ruttenberg, *American Federation of Labor and Congress of Industrial Organizations*
Murray Shields, *American Management Association*
Willard L. Thorp, *American Economic Association*
W. Allen Wallis, *American Statistical Association*
Harold F. Williamson, *Economic History Association*

DIRECTORS EMERITI

Oswald W. Knauth, *Beaufort, South Carolina*
Shepard Morgan, *Norfolk, Connecticut*
N. I. Stone, *New York City*

RESEARCH STAFF

Moses Abramovitz
Gary S. Becker
William H. Brown, Jr.
Gerhard Bry
Arthur F. Burns
Phillip Cagan
Joseph W. Conard
Frank G. Dickinson
James S. Earley
Richard A. Easterlin
Solomon Fabricant
Milton Friedman
Raymond W. Goldsmith
Millard Hastay
Daniel M. Holland
Thor Hultgren
F. Thomas Juster
C. Harry Kahn
Hal B. Lary
Robert E. Lipsey
Ruth P. Mack
Jacob Mincer
Ilse Mintz
Geoffrey H. Moore
Roger F. Murray
Ralph L. Nelson
G. Warren Nutter
Richard T. Selden
Lawrence H. Seltzer
Robert P. Shay
George J. Stigler
Norman B. Ture
Herbert B. Woolley

Relation of the Directors to the Work and Publications of the National Bureau of Economic Research

1. The object of the National Bureau of Economic Research is to ascertain and to present to the public important economic facts and their interpretation in a scienific and impartial manner. The Board of Directors is charged with the responsibility of ensuring that the work of the National Bureau is carried on in strict conformity with this object.

2. To this end the Board of Directors shall appoint one or more Directors of Research.

3. The Director or Directors of Research shall submit to the members of the Board, or to its Executive Committee, for their formal adoption, all specific proposals concerning researches to be instituted.

4. No report shall be published until the Director or Directors of Research shall have submitted to the Board a summary drawing attention to the character of the data and their utilization in the report, the nature and treatment of the problems involved, the main conclusions, and such other information as in their opinion would serve to determine the suitability of the report for publication in accordance with the principles of the National Bureau.

5. A copy of any manuscript proposed for publication shall also be submitted to each member of the Board. For each manuscript to be so submitted a special committee shall be appointed by the President, or at his designation by the Executive Director, consisting of three Directors selected as nearly as may be one from each general division of the Board. The names of the special manuscript committee shall be stated to each Director when the summary and report described in paragraph (4) are sent to him. It shall be the duty of each member of the committee to read the manuscript. If each member of the special committee signifies his approval within thirty days, the manuscript may be published. If each member of the special committee has not signified his approval within thirty days of the transmittal of the report and manuscript, the Director of Research shall then notify each member of the Board, requesting approval or disapproval of publication, and thirty additional days shall be granted for this purpose. The manuscript shall then not be published unless at least a majority of the entire Board and a two-thirds majority of those members of the Board who shall have voted on the proposal within the time fixed for the receipt of votes on the publication proposed shall have approved.

6. No manuscript may be published, though approved by each member of the special committee, until forty-five days have elapsed from the transmittal of the summary and report. The interval is allowed for the receipt of any memorandum of dissent or reservation, together with a brief statement of his reasons, that any member may wish to express; and such memorandum of dissent or reservation shall be published with the manuscript if he so desires. Publication does not, however, imply that each member of the Board has read the manuscript, or that either members of the Board in general, or of the special committee, have passed upon its validity in every detail.

7. A copy of this resolution shall, unless otherwise determined by the Board, be printed in each copy of every National Bureau book.

(*Resolution adopted October 25, 1926, as revised February 6, 1933, and February 24, 1941*)

This study, one of a series dealing with Soviet economic growth, was made possible by funds granted by the Rockefeller Foundation. The Rockefeller Foundation is, however, not to be understood as approving or disapproving by virtue of its grant any of the statements made or views expressed herein.

Contents

PREFACE xvii

FOREWORD, by G. Warren Nutter xix

1. COMPOSITION AND GROWTH OF SOVIET AND UNITED STATES FREIGHT TRANSPORTATION 1

A Railroad Economy 1
Water Transport 3
Truck Transport 9
Petroleum Pipelines 11
Aggregate Intercity Transportation 13
Transportation in the United States 17
Comparisons of Soviet and United States Traffic 25

2. SOVIET RAILROAD TRAFFIC 33

Statistical Measures 33
Growth of Soviet Rail Freight Traffic 39
Freight Traffic Performance in War 49
Postwar Developments 56
Railroad Passenger Traffic 58

3. FACTORS AFFECTING SOVIET RAILROAD TRAFFIC 63

Control of Freight Traffic 63
Use of Rates in Control of Traffic 68
Zoning 72
Control of Traffic Variation Through Storage at Origin 74
Planning of Traffic Movement 75
Comparison of Soviet and U.S. Average Hauls 76
Composition of Freight Traffic 78

4. AN ANALYSIS OF SOVIET RAILWAY OPERATION 89

The Nature of Soviet Railway Operations 89
Usefulness of Study 89
Relationship of Railway Development to the Economy at Large 90

Soviet Use of Plant and Equipment 98
Intensive Utilization 98
Permanent Way 99
Yard and Terminal Facilities 103
Motive Power Utilization 106
Freight Car Equipment 111
Certain Measures of Efficiency 121
Fuel 121
Labor 124
Effects of Partial Dieselization 129

5. CONCLUSIONS 133

APPENDIX A: Railroad Performance vs. Capital Investments During the Transportation Crisis in the USSR, 1931-35, by George Novak 141

APPENDIX B: Soviet Maritime Freight Traffic Statistics, by George Novak; revised and extended by Holland Hunter 157

APPENDIX C: Basic Series on Soviet Transportation, by George Novak; revised and extended by Holland Hunter 169

BIBLIOGRAPHY 209

INDEX 215

TABLES

1. Soviet Freight Traffic, Selected Years, 1913-60 14
2. United States Intercity Freight Traffic, Selected Years, 1890-1959 18
3. United States and Soviet Total Freight Traffic, Selected Years, 1890-1959 25
4. Soviet Railways, Index Numbers, Selected Years, 1913-54 28
5. United States and Soviet Postwar Growth of Freight Traffic, Index Numbers 30
6. Soviet Postwar Growth of Rail Traffic Compared with Other Periods in the United States, Index Numbers 30
7. Average Daily Carloadings, USSR, 1932-33, by Month 43
8. Soviet Freight Traffic, 1942-44 55
9. Soviet Freight Traffic Density, 1939, 1945-54 56
10. Soviet Passenger Traffic, 1949-57 61
11. Average Daily Carloadings of Soviet Railways, 1934-38, by Month 65
12. Comparison of Average Haul on U.S. and Soviet Railways, 1928-39, 1950, 1959 77
13. Composition of Soviet Freight Traffic, Five-Year Intervals, 1930-58 78
14. Composition of U.S. Freight Traffic, Five-Year Intervals, 1930-58 80
15. Composition of U.S. and Soviet Freight Traffic, Five-Year Intervals, 1930-58 81
16. Composition of U.S. and Soviet Freight Traffic, Five-Year Intervals, 1940-58 82
17. Comparison of Elements of Turnaround: United States, 1933, and Soviet Union, 1940 105
18. U.S. Locomotive Performance, Selected Years 108
19. Locomotive Performance, United States and Soviet Union, Selected Years 110
20. Comparison of Freight Car Turnaround Time, United States and Soviet Union, by Components 117
21. Locomotive Fuel Consumption, Soviet Railroads, 1928-40 and 1945-59 122
22. Distribution of Railroad Labor Force in United States and Soviet Union, 1950 126
23. Comparison of Labor Productivity in United States and Soviet Union, Selected Years 128

24. Percentage of Total Gross Freight Ton-Kilometers Performed by Steam Traction, U.S. and Soviet Railroads 130
25. Comparison of Railroad Operating Statistics, United States and Soviet Union 131

A- 1. Average Daily Carloadings and Backlog of Unshipped Freight, 1930-31 142
A- 2. Performance of Railroads, 1933-34 143
A- 3. Average Daily Output of Major Industrial Commodities, 1933-34 144
A- 4. Average Daily Carloadings, 1933-36, by Month 146
A- 5. Breakdown of Increase in Average Daily Carloadings in 1935 by Causal Factors 146
A- 6. Detention of Freight Cars at Divisional and Classification Stations, 1933-35 147
A- 7. Train and Rolling Stock Performance, 1935 147
A- 8. Utilization of Locomotive Stock, 1934-35 148
A- 9. Average Daily Carloadings and Breakdown of Turnaround Time of Freight Cars, 1934-35 148
A-10. Breakdown of Increase in Average Daily Carloadings by Causal Factors, 1934-35 149
A-11. Technical and Average Section Speeds of Freight Trains, 1913, 1928-36 149
A-12. New Freight Locomotives Produced and Delivered to Railroads, 1927/28-40 151
A-13. New Freight Cars Produced and Delivered to Railroads, 1927/28-38 152
A-14. Comparison of Annual Changes in Stocks of Freight Cars with Annual Deliveries of New Freight Cars to Railroads, 1928-37 153
A-15. Comparison of Annual Changes in Inventory Fleet of Freight Cars with Annual Production of New Freight Cars, 1928-37 153
A-16. Breakdown of Increase in Average Daily Carloadings in 1935 by Causal Factors, Based on Revised Active Fleet 154

B- 1. Total Maritime Traffic Carried in Soviet Bottoms, 1928-35 158
B- 2. Domestic Maritime Traffic Carried in Soviet Ships, 1929-35 160
B- 3. Estimated Average Length of Haul, Domestic Maritime Traffic, 1913, 1928-35 161
B- 4. Local Maritime Traffic, 1913, 1928-35 162

B- 5. Petty Cabotage Maritime Traffic Carried in Soviet Bottoms, 1913, 1928-35 162
B- 6. Grand Cabotage Maritime Traffic Carried in Soviet Bottoms, 1913, 1928-35 163
B- 7. Local Maritime Traffic Carried in Soviet Bottoms, 1913, 1928-35 163
B- 8. Domestic Maritime Traffic Carried in Soviet Bottoms, 1913, 1928-35 164
B- 9. Adjusted Domestic Maritime Traffic Carried in Soviet Bottoms, 1913, 1928-35 164
B-10. Soviet Maritime Freight Traffic, Total, Petty Cabotage, and Other, 1945-59 166

C. Basic Series on Soviet Transportation 169
I. Railroad Freight Traffic 170
C-1. Tariff Ton-Kilometers 170
C-2. Tons Originated 170
C-3. Average Length of Haul 170
C-4. Average Daily Carloadings 171
C-5. Average Load per Car 171
C-6. Operating Ton-Kilometers 171
C-7. Commodity Composition, Tons Originated 172
C-8. Commodity Composition, Ton-Kilometers 172

II. Railroad Passenger Traffic 173
C-9. Total Passenger-Kilometers 173
C-10. Total Passengers 173
C-11. Average Length of Total Trip 173
C-12. Long-Distance Passenger-Kilometers 173
C-13. Long-Distance Passengers 174
C-14. Average Length of Long-Distance Trip 174
C-15. Suburban Passenger-Kilometers 174
C-16. Suburban Passengers 174
C-17. Average Length of Suburban Trip 174

III. Freight Train Performance 175
C-18. Average Section ("Commercial") Speed 175
C-19. Average "Technical" Speed 175
C-20. Average Gross Train Weight 175
C-21. Average Net Train Weight 175
C-22. Total Train-Kilometers 175

IV. Locomotives 176
C-23. Locomotives in Inventory Fleet 176
C-24. Total Tractive Effort of Locomotives in Inventory Fleet 176
C-25. Average Daily Kilometers per Locomotive-Day 176

V. Freight Cars 177
C-26. Active Fleet, Revenue Trains 177
C-27. Fleet Under Railroad Jurisdiction 177
C-28. Percentage of Four-Axle Units in Total Inventory Fleet 177
C-29. Turnaround Time, Active Fleet 177
C-30. Average Daily Kilometers per Active Car-Day 178
C-31. Average Total Turnaround Trip 178
C-32. Average Loaded Turnaround Trip 178
C-33. Average Empty Turnaround Trip 178

VI. Railroad Network and Traffic Density 179
C-34. Total Road Operated, Annual Averages 179
C-35. Total Road Operated, End of Year 179
C-36. Freight Traffic Density 179
C-37. Passenger Traffic Density 179

VII. Railroad Labor Force and Productivity 180
C-38. Composite Passenger-Ton-Kilometers 180
C-39. Labor Productivity 180
C-40. Operating Labor Force 180

VIII. Powered Freight Traffic on Inland Waterways 181
C-41. Ton-Kilometers 181
C-42. Tons Originated 181
C-43. Average Length of Haul 181

IX. Maritime Freight Traffic Carried in Soviet Bottoms 182
C-44. Total Ton-Kilometers 182
C-45. Total Tons Originated 182
C-46. Average Length of Total Haul 182
C-47. Domestic Ton-Kilometers 183
C-48. Domestic Tons Originated 183
C-49. Average Length of Domestic Haul 183

X. Oil Pipeline Traffic 184
C-50. Ton-Kilometers 184

C-51. Tons Originated 184
C-52. Average Length of Haul 184

XI. Motor Freight Traffic 185
C-53. Ton-Kilometers 185
C-54. Tons Originated 185
C-55. Average Length of Haul 185

CHARTS

1. Soviet Freight Traffic, Selected Years, 1913-60 16
2. U.S. Intercity Freight Traffic, Selected Years, 1890-1959 20
3. Comparison of U.S. and Soviet Total Freight Traffic, Selected Years, 1890-1959 26
4. U.S. and Soviet Railroad Freight Traffic, Selected Years, 1890-1959 28

Preface

THIS study of Soviet freight transportation is a rather thorough revision of an earlier working memorandum which was circulated for comment and criticism. The original analysis was based upon extensive background research undertaken by George Novak with the Soviet sources and upon the nearly completed investigation by Holland Hunter from which his *Soviet Transportation Policy* was developed. Novak developed the statistical series upon which much of the analysis rests. In addition, he prepared various special analyses of railroad and maritime reporting and statistical methods, and brought together considerable qualitative evidence bearing upon the character of Soviet transport operations.

About the time that the working memorandum was ready for circulation, the Soviet Union released much additional statistical information, including important series which had not been reported since the mid-thirties. In preparation for this revision, Hunter reviewed these newly published data and revised all of the basic tables. This has permitted a far more simple presentation and has made possible the substitution of published for calculated or estimated observations in many of the series. On the whole, however, the data worked out with considerable ingenuity by Novak have stood the test of comparison with the more recently published material and have permitted an analysis to be made in advance of the release of more comprehensive data.

The revision has benefited by the careful review given the working memorandum by Melvin G. de Chazeau, Holland Hunter, Thor Hultgren, G. Warren Nutter, Harry Scherman, and Boris Shishkin. In addition, it has been possible to consider the reports of the railway and water carrier missions which went over to the USSR in an exchange program during 1959 and 1960, even though the complete observations of these missions are not yet available. The suggestions of Geoffrey Moore have been of particular help in the revision of Chapter 1. Marie-Christine Culbert has undertaken with great industry and patience the onerous task of checking and arranging tables and sources, as well as general editorial work which has lent clarity to the text. H. Irving Forman drew the charts.

For the interpretation of data, despite generous help, the author must accept sole responsibility.

July 1961 ERNEST W. WILLIAMS, JR.

Foreword

THIS is the third in a series of books reporting the results of a study of Soviet economic growth begun at the National Bureau in 1954 under a grant from the Rockefeller Foundation.[1] It shifts the scene from industry, the subject of the first two reports, and surveys instead the structure, growth, and mode of operations of Soviet transportation.

The primary objective is to assess Soviet performance in moving freight, a matter of interest in itself but also important for checking measures of growth independently calculated for other sectors, particularly industry and agriculture. This requires, first, an understanding of the unique characteristics of Soviet transportation, to which Professor Williams contributes at the start by contrasting trends in Soviet and American transportation. The Soviet Union, as Williams notes in his opening words, has always been and has increasingly become a "railroad economy." In no period covered by statistics has the railroad dominated transport in the United States to the same extent as in the Soviet Union. In recent years the fraction of commercial freight traffic accounted for by rail transport has risen to nine-tenths in the Soviet Union while falling to less than four-tenths in the United States. Precisely for this reason the simple comparisons that are sometimes made between isolated statistics on Soviet transportation and developments in the United States can be highly misleading.

Since the history of Soviet transportation is essentially the history of rail transport, the latter forms the subject of the remainder of the book. As usual in studies of the Soviet economy, the initial problem is to audit the basic data, to evaluate their meaning and reliability. Again as usual, there are severe limits to what can be learned from direct analysis of Soviet statistical sources, but within those limits Williams leads us through the maze of Soviet data by comparing them with their apparent American counterparts. We discover that, by virtue of differences in concepts and methods of compilation, Soviet traffic statistics are exaggerated relative to their American counterparts and more so for later than for earlier years. Unfortunately, the degree of exaggeration can only be guessed at, though Williams believes it could easily be as high as 10 per cent for recent years.

[1] Gregory Grossman, *Soviet Statistics of Physical Output of Industrial Commodities: Their Compilation and Quality*, Princeton University Press for National Bureau of Economic Research, 1960; and G. Warren Nutter, *Growth of Industrial Production in the Soviet Union*, Princeton for NBER, 1962.

Those versed in the operations of Western railroads have long suspected that something was wrong with the figures because plant and equipment, as reported in Soviet statistics, seem to be insufficient to support the claimed traffic. Williams finds this suspicion to be well grounded and points out that it results from faulty statistics on both sides: underreporting of rolling stock as well as overreporting of traffic. The explanation lies in the dual emphasis placed by Soviet authorities on meeting targets in both haulage of freight and utilization of equipment, which, when taken together with inadequate auditing of data reported to statistical authorities by operating units with a stake in the figures they report, leads to uncorrected misreporting of data in the indicated directions.

While the statistical illusion is real enough, it is by no means the end of the story. After a careful analysis of Soviet railroad operations compared with practices in the United States, a similar continental economy from the point of view of transport problems, Williams concludes that the Soviet railway system has in fact achieved an unusually intensive utilization of plant and equipment. He attributes the exceptional performance in this regard to the following factors: close scheduling of all trains at standard speeds, freight having general priority over passengers; collecting and delivering of goods at the convenience of the hauler, even at seasonal peaks, with a constant backlog of goods awaiting shipment; rapid loading and unloading, day and night, by a work force about three-quarters as large as the more narrowly defined operating personnel; organizing of work under virtual military discipline; standardizing of equipment with heavy reliance on all-purpose open cars; operating of a simple, noncompetitive rail network; and so on. The resulting service is, by the same token, quite different in nature from that provided by Western railroads. As Williams shows by a number of interesting examples, when American railroads have operated under similar circumstances, they have achieved comparable densities of traffic and intensive utilization of equipment.

While the comparisons made in this study between the Soviet and U.S. transportation systems and their growth trends are designed primarily to aid analysis of such specific issues as those just mentioned, they have a broader interest as well. At the same time, this work does not pretend to be a definitive study of comparative economic performance in the transportation sector of those two economies. For example, the important question of productivity of resources is but

briefly touched upon, and then only in the case of narrowly defined railroad operating personnel (see Table 23 and the surrounding text). Measures of labor productivity based on total employment would come out quite differently from those shown in that particular case, primarily because persons engaged in loading and unloading activities, not counted in the operating work force, are so much more important in the Soviet Union than in the United States. There are serious difficulties in interpreting Soviet data on employment in the transportation sector and in making them comparable with U.S. data, but we may suppose they are no different in kind from those posed by other types of data. In any event, we hope to present in a later report in this series a more comprehensive analysis of levels and trends in labor productivity appropriately compared with performance in the United States, a task now greatly lightened by the publication of John W. Kendrick's *Productivity Trends in the United States.*[2]

We also plan in the later report to examine the consistency between measured growth trends for transportation and for other sectors of the Soviet economy. It is already possible to note certain roughly parallel developments in Soviet and U.S. economic history. In the Soviet Union, freight traffic multiplied about 13.5 times and industrial output about 7.5 times between 1913 and 1958; in the United States, transportation output multiplied about 13.9 times and industrial output about 8.9 times between 1875 and 1920, a comparable period in the sense that U.S. industrial output in 1875 was at more or less the same level as in the Soviet Union of 1913.[3] This kind of comparison is obviously crude and unsatisfactory in and of itself, but it indicates promising fields for further exploration.

We cannot, therefore, assess as yet the full importance of specific elements in the large body of information that Williams has brought to bear on the phenomenon he has studied: growth of productive activity in the sphere of Soviet transportation. We can, however, be sure that his work has moved us well forward in our successive approximations to knowledge and understanding. And this is the basic test of successful research.

G. WARREN NUTTER
Director, Study of Soviet Economic Growth

Charlottesville, Virginia

[2] Princeton for NBER, 1961.

[3] These figures are derived from this book, Table 1; Kendrick, *Productivity*, p. 540; and Nutter, *Industrial Production*, pp. 196 and 227.

Freight Transportation in the Soviet Union

CHAPTER 1

Composition and Growth of Soviet and United States Freight Transportation

A Railroad Economy

From the point of view of its transportation plant and the allocation of freight and passenger traffic among the several transportation agencies, the Soviet economy is and always has been a railroad economy. Despite the emphasis placed upon the development of other forms of transportation, railroads, which in 1913 had handled 61 per cent of freight traffic, were built up until by 1940 they handled 87 per cent. The economy of the United States has never been so greatly dominated by rail transport as the Soviet economy has during and since the second war, and the trends in this country have been the opposite of those in the Soviet Union. Hence Soviet traffic in recent years can be quite well understood through a study of the railroads alone and the greater part of the subsequent chapters will, therefore, be devoted to Soviet rail operations.

It is impossible for an American familiar with transportation in his own country to study Soviet transportation and to obtain the greatest meaning from his work without making continual comparisons with conditions in the United States which are better known to him and which can serve as background for analysis of the available Soviet data. Moreover, a primary purpose of this study is to examine and compare with the U.S. the growth of Soviet transport, to consider the validity of the Soviet growth, and to secure an understanding of whether and how that growth has been possible from the limited capital inputs which Soviet policy has devoted to the transport sector of the economy. Occasional reference is made to European practice, but the Soviet railroads have in particular sought to emulate U.S. practice as more appropriate to their large tonnages and great distances and, except for Germany, a similar abundance of operating and traffic statistics is not available among the larger European countries.

For someone who is not a student of transportation, it is necessary to provide a clear picture of American conditions if comparisons are to be indulged in, for they have not been understood fully even within the transportation industries. Hence many comparisons between American and Soviet data have been, to a certain extent, misleading. Our approach, therefore, requires some development of data for the United States after we have brought together available traffic data for the

Soviet Union. Only a comparison of aggregate traffic in the two countries will provide some understanding of the comparative supply and growth of transportation, and this will become all the more apparent as we proceed. Air transportation will, however, be neglected for both the Soviet Union and the United States. The emphasis here is almost entirely upon freight transportation which is of primary interest for what it may disclose about economic growth. In neither country has cargo transportation by air reached a sufficient level to have any significant effect upon the aggregate of freight transportation.[1] We shall have occasion to devote a few pages to rail passenger transportation, however, because it affects rail transportation of freight. While civil air transport has been important for urgent and official passenger travel, the volume of traffic remains minor by comparison with that in the United States, and railroads remain the principal means of passenger transport on intercity routes.[2]

A discussion of forms of Soviet transport other than rail in this first chapter will permit their contributions, strengths, and weaknesses to be understood and will provide a background for the presentation of aggregate freight traffic data by all forms of transportation. In later chapters the discussion will focus primarily on rail traffic and operations. It will also be helpful to keep in mind the organizational pattern of the transport system, especially since it often affects the form and content of the statistical materials and sometimes their quality as well. Separate ministries exist for rail, inland river, and maritime transport, and the administration of these forms of transport remains centralized. The People's Commissariat for Water Transport was, in 1939, divided into the River Fleet and Maritime Fleet Commissariats, subsequently renamed ministries. Much water transport was organized under yet another ministry, although considerable motor transport has always

[1] In the United States, goods transportation by air, including the mails, represents approximately 0.02 per cent of the freight ton-miles. In 1958 Soviet air passenger traffic (including international) was roughly one-sixth of the U.S. domestic air passenger volume. Although no absolute data have been published on air cargo in the USSR, its growth appears to have been given much less emphasis than the passenger services. See *ICAO Bulletin* (International Civil Aviation Organization), June 1961, p. 86.

[2] Since 1956 Soviet civil air passenger service has begun a very rapid growth, using newly introduced aircraft of advanced design. For recent traffic estimates, see *Comparisons of the United States and Soviet Economies*, U.S. Congress, Joint Economic Committee, Washington, 1959, Part I, p. 196. For details on routes and aircraft, see George Kish, "Soviet Air Transport," *The Geographical Review*, July 1958, pp. 309-320, and Hans Heymann, Jr., "The Soviet Role in International Civil Aviation," *Journal of Air Law and Commerce*, summer 1958, pp. 265-280. A recent appraisal by Stuart Tipton, "The Soviet Challenge in Civil Aviation," was published in *The General Electric Defense Quarterly*, April-June 1961, pp. 26 ff.

been controlled by nontransport ministries. Control of motor transport has, however, been decentralized along with industry in general. For operating purposes the railroad system is regionalized under railroad administrations, generally referred to as railroads. These do not, of course, have the autonomy of an American railroad corporation, but correspond more nearly with the regions or divisions of an American railroad. Since these railroad administrations do not correspond with the regions to which administration of the majority of economic functions was confided in the decentralization move, some complexity has no doubt been introduced into the relationships between railroad administrations and the administrations responsible for industrial functions. Finally it may be noted that pipeline transportation, quite logically, is administered as a part of the petroleum production organization.

Water Transport

All types of transportation have undergone some development in the Soviet Union. Extensive use had been made of the inland waterways, and maritime traffic had been developed on the Caspian, Baltic, and Black Seas in the period before the revolution. As in other countries, the waterways had provided the principal means of bulk transportation prior to the development of a comprehensive rail network. The Soviet Union, however, has not been favored by nature with many navigable watercourses and the extensive improvement of certain channels has not overcome the fact that the location of the waterway system does not correspond, with some exceptions, to the more important traffic flows generated by resource location and population concentration. Hence, although second only to the railroads in its contribution to traffic, water transportation has experienced only a modest development and one obviously disappointing to the planners[3] and to such officials as Kaganovich and the Minister of Transportation, whose policies have, over the years, sought a more significant relief for railways in waterway development.[4] The complaint repeated over and over again in

[3] By comparison with railways, water-carrier operations—particularly in river transport—usually call for a smaller input of critical materials, particularly iron and steel, to achieve a given ton-mile output. On the other hand, the difficulty of obtaining return loads because of the character of traffic flows is a serious impediment in the Soviet case and, indeed, often limits water-carrier development in transportation systems elsewhere.

[4] Both inland and maritime water transport again failed to reach the levels planned for them in 1950. Compare *Five Year Plan for the Rehabilitation and Development of the National Economy of the USSR, 1946-1950,* London, 1946, pp. 48 ff, with 1940 and 1950 data in series C-41 and C-49 in Appendix C. The shortfall in maritime traffic was the most serious. More recent growth has been of some consequence but has afforded no significant relief to railroads.

speeches of Party and other officials and in the press is of inefficiency and lack of initiative and energy on the part of the water carriers and their administrators. Characteristic of such statements is the following:[5] "Sabotage by enemies of the people and laxity and weak discipline among some of the workers in river and sea transport have caused these sectors to lag. Every measure has been taken by the Government to eliminate this backwardness."

Neither the conditions nor the causes thereof appear to be correctly portrayed by any such statements and, in the light of the attention focused on the prospects of water transport as a relief to the railroads, it is well to pay some attention to the possibilities of a more revealing description.

Soviet water transport falls into three departments: maritime traffic in foreign trade, maritime traffic in domestic trade, and traffic on rivers, canals, and other inland waterways.[6] The first of these will be disregarded here as it is not a portion of Soviet internal transportation, although the readily available data appear in the statistical appendix. The domestic phases of water transport have developed under unfavorable natural conditions. Nevertheless, it also appears that technology in river and domestic maritime trades has lagged behind the best practices elsewhere and that laxity in the handling of cargoes and the lack of solicitation of traffic by the water transport authorities have aggravated the natural disadvantages.[7] At the same time, the shortage of materials and components connecting stages of production appears to have put a premium upon rapidity of movement.

The inland waterways in the areas of older development comprise particularly the Volga and its tributaries, which before the war were reported to account for 45 per cent of the river traffic; the White Sea-Baltic and Moscow-Volga Canals; and the Dnieper and the Don with their tributaries. The Volga, in conjunction with the canals mentioned, provides an inland waterway which extends without interruption from the Caspian to the White Sea, while the postwar Volga-Don Canal extends navigation via the Don into the Sea of Azov and thence into the Black Sea. The route is, however, extraordinarily roundabout, as is frequently true of rivers in relatively flat country.

[5] S. S. Balzak, V. F. Vasyutin, and Ya. G. Feigin, *Economic Geography of the USSR* (translated from the Russian), New York, 1949, p. 476.

[6] Statistical data for all three departments are presented in Appendix C, series C-41 through C-49. Total freight traffic on inland waterways under the jurisdiction of the Ministry and other organizations is not given here since these data are not available after 1932. For maritime traffic, Appendix B should be consulted.

[7] The failure to relate water to rail rates is also, no doubt, of importance and is commented upon in Chapter 2.

The Dnieper and the Don have failed to develop any very significant traffic. Unlike the Volga, they do not reach the important industrial regions of the Northwest. Neither do they effectively tap the Donbas, the principal resources of which are remote from the navigable rivers. No effective water connection exists between the Donbas and the Moscow Basin or the Urals in view of the extreme circuity of the Volga route.[8] In short, these rivers are not well located as regards the basic mineral resources upon which the industrial economy is founded. The Volga, however, is in part a useful water route for the movement of oil from the Caucasus and grain from its tributary areas and for the southbound movement of lumber for transshipment into the Donbas and Caucasus. The less intensive development of railways in the territory served by the lower Volga no doubt contributes to the importance of the river and results, in part, from the relative efficiency of the water route. But the Volga route into the Moscow and Leningrad areas is far too indirect to prove attractive even for low-grade bulk traffic. Hence local movements are characteristic and through traffic the exception. Indeed the joint water-rail petroleum movement northbound has been superseded by all-rail movement to a certain degree, while a short-haul local distribution of petroleum from the "second Baku," the new midcontinent producing field, has come into existence.[9]

The northern rivers of European Russia, notably the Northern Dvina and the Pechora, are vital to the development of the area in the absence of railways. They are devoted largely to the rafting of timber to vessels of the maritime fleet operating in the White and Barents Seas and, in the case of the Pechora, to the movement of coal from Vorkuta. Similarly, the Siberian rivers accommodate considerable lumber traffic. As none of these rivers were tapped by the railroad system from the south within the range of their navigability until recently, they served primarily to feed the Northern Sea Route, and hence were distinctly limited in their

[8] In consequence, heavy capital expenditures have been made to develop principal rail routes between these areas in order to provide accommodation particularly for the traffic in coal, ores, and other bulk commodities which are often amenable to water transportation where the waterways are reasonably well adapted to the resource pattern.

[9] Considerable material has been brought together by Holland Hunter in his *Soviet Transportation Policy*, Cambridge, Mass., 1957, Chapter 8. He is certainly correct in offering the heavy costs of transshipment as a major reason for the failure of joint movements to develop to a greater degree. The "second Baku" lies in the Kuibyshev-Perm area. On this development, see Edmund Stevens, "The World's No. 2 Oil Producer—the U.S.S.R.," *Fortune*, June 1961, pp. 132 ff.

economic usefulness by the extreme shortness and uncertainty of the navigation season along that route. Nevertheless, the rivers of the northwest and the Siberian and Central Asian rivers are said to have accounted for 15.3 and 12.2 per cent, respectively, of the 1937 river traffic.[10] The extension of the northern rail route to the Ob' presumably enables the latter stream to serve as a feeder for the rail system and also to distribute upstream (southward) from railhead at Salekhard. In various parts of the country, rivers—large and small—are employed for the local transportation of agricultural produce, lumber, sand, and other commodities to railhead, but in the aggregate these short-distance movements create no great volume of traffic.[11] Some of this traffic, carried in small boats, may escape the statistics.

Not only are the Soviet inland waterways poorly located with respect to resources long since prospected, but no waterways of importance exist in the areas of newer industrial development; nor are there any which can carry much east-west traffic, which has become of growing importance. Moreover, the disadvantage of circuity is supplemented by the greater disadvantages of seasonality and of unreliability of channel depths. The rivers of European Russia are navigable six to eight months of the year and are closed by ice during the remainder of the year. Those of Arctic Russia are open from five to seven months, but certain of them are accessible from the sea only during a much shorter period and then only by organized convoys traveling the Northern Sea Route in the company of icebreakers, the supply of which has not been adequate. In most parts of the country the navigation season is not only short, but also uncertain, which is an impediment to long-distance movements toward the latter part of the season since they run the risk of being closed out by ice conditions. Similarly, there is a tendency, when pressure to ship is heavy, for a build-up of the river traffic to be slow in the spring, the railroads being used as a precaution against late opening, which might result in traffic being tied up at the ports of transfer.

Not much information has come to hand on the equipment and the character of operations even on the principal streams. No considerable investigation has been made of this subject. It appears, however, that there has been a lag in the technological development of river operations and that the European rather than the American pattern is

[10] Balzak, *et al.*, *Economic Geography*, p. 476.

[11] The absence of a suitable branch-line development over the newer portions of the rail network and the absence of a developed highway network leave many collective farms dependent upon small streams for their access to railway lines.

followed.[12] Moreover, the equipping of ports has lagged. Rail connections to piers have not been provided in some instances and the supply of cranes and particularly of heavy-lift cranes has been inadequate.[13] All principal types of handling equipment known in the United States are, however, employed to some extent. Hence the economy of movement obtained from large integrated tows does not appear to be secured; neither is expeditious transfer between land and water transport universally provided. In the United States, traffic on the inland rivers has been, in recent years, the fastest growing part of the freight business. The activity of aggressive enterprises, whose success depends upon an ability to divert traffic from the land routes and which therefore do their utmost to develop rate and service incentives, to influence industrial location, and to solicit traffic, has certainly been important in stimulating this development. By way of contrast, Soviet waterway operators appear to be passive and not given to the intensive efforts necessary to overcome their natural handicaps. It is also noteworthy that an important and growing part of American inland water transport is by private carrier, i.e., operated by industrial enterprises. The proportion of powered inland water traffic operated in the Soviet Union by organizations other than the Ministry is small and appears to be declining. As has often occurred elsewhere, large expenditures to improve navigation appear to have yielded small dividends in comparison with what was expected. For in 1954 the inland waterway traffic stood at little more than double the 1913 figure although railway traffic had multiplied thirteen times. The lack of a system such as that of the Great Lakes, which is further

[12] American river transportation has relied on tows built up ahead of the towboat, firmly lashed to it, and therefore pushed as a single unit. European operations, on the other hand, have used towed barges strung out behind the towboat, as is common in our coastal waters. The American system on the rivers permits tows that are very large (often exceeding 10,000 tons on the better channels and running as high as 35,000 tons), yet highly maneuverable. Integration of the tow to achieve better underwater form has reduced resistance and permitted a considerable increase in speed. A trend toward self-propelled boats is reported in the USSR, but it appears that the horsepower of Soviet river craft is generally less than in the U.S. See "Inland Waterway Officials Say Russia Plans Diversification of Transportation Facilities," *Traffic World*, October 22, 1960, p. 53.

[13] For a discussion of the astonishing lack of capacity to unload and turn ships at Archangel, see C. B. A. Behrens, *Merchant Shipping and the Demands of War*, London, 1955, pp. 253 ff. The recent mission of U.S. inland waterway officials was, however, well impressed with the coordination between rail and water and referred to new and expanded river-rail terminals being "built everywhere." Moreover containers have evidently come into substantial use, since the Ministry of the River Fleet is said to own 200,000 of them. (See *Traffic World*, October 22, 1960, p. 53.) Joint rail-water shipments have, indeed, grown and now stand considerably above the prewar level. Yet they represent only 10 per cent of the originated river tonnage.

commented upon in Chapter 3, makes the Soviet inland waterway traffic compare poorly in relative volume and in economic significance with that of the United States. Actually, it is not far behind our inland waterway traffic if the Great Lakes are excluded, but does not appear to be enjoying the rapid expansion of our river traffic in the past several years.

Although there has been a growth in joint shipments between rail and water, it has been quite modest by comparison with the growth of all-rail traffic. The reporting of such shipments is, however, evidently far from complete since it records only such shipments as move under through billing. These data are as follows for directly reported joint rail-water shipments in million metric tons originated:

Year	River to Railroad	Railroad to River	Combined	Percentage of Total River Tons Originated
1928	0.50	0.30	0.80	2.0
1932	1.40	0.60	2.00	2.8
1939	2.63	2.19	4.82	6.6
1940	3.01	2.31	5.32	7.2
1945	0.40	1.07	1.47	4.1
1949	2.00	3.31	5.32	7.3
1950	3.29	4.49	7.78	9.1

SOURCE: V. V. Zvonkov, *Vzaimosviaz' otdelnykh vidov transporta i osnovy organizatsii smeshannykh perevozok* [The Interrelation of Different Types of Transport and Principles for Organizing Joint Shipments], Moscow, 1953, p. 5.

In comparison with the 834.3 million tons originated on the railroads in 1950, these joint shipments are small indeed. Soviet data indicate that the costs of river transportation (excluding the costs of channel maintenance) are not notably below rail costs. Thus, for 1956, they show a river cost of 3.41 kopeks per equated ton-kilometer compared with 3.7 kopeks by rail. The closeness of these data results in part, of course, from the relative circuity of many of the river routes.[14]

Domestic maritime traffic is also severely handicapped. The Soviet Union has no connected coastline but has instead limited ranges for maritime coastwise trade in the Black Sea, Baltic Sea, and White Sea and on the Pacific seaboard. Weather and ice conditions prevent large-scale use of the Northern Sea Route despite extensive work to improve Arctic navigation. All routes connecting these several coastal areas require highly circuitous movements. Hence the heaviest coastal traffic is on relatively short hauls within the Black Sea and the Sea

[14] *Transport i sviaz' SSSR* [Transportation and Communications in the USSR], Moscow, 1957, p. 24.

of Azov. Operations on the Caspian also come within the jurisdiction of the Maritime Fleet, but are more akin to lake transportation than to the usual run of coastwise operations. Except for movements for the iron and steel industry and the petroleum trade in the Black, Azov, and Caspian Seas and for the lumber and coal trades in the White Sea, heavy commodity movements are not readily accommodated to maritime transport.

It will be observed from series C-43 and C-49 in Appendix C that there has been a tendency toward a shorter average haul, both in inland waterway and in the coastwise trades, since the early 1930's. Indeed the length of haul upon inland waterways appears to decline markedly as early as 1929, while that in the coastwise trade breaks after 1933. By comparison with the lengthening average haul by rail, that of sea transport is of somewhat equivalent length in recent years, while the inland waterways show a short average haul, indicating the predominance of relatively local traffic. The increasing importance of the short-haul Baltic trade, in line with territorial acquisition, must have had its effect upon the length of haul in maritime traffic, but can hardly fully explain this sharp shift. Notwithstanding the heavy expenditures for the improvement of inland waterways, no evidence appears of the development of large-scale, long-distance traffic over these routes, although the development of predominantly short-haul movements on the northern and Siberian rivers may have some slight influence in holding this datum in the vicinity of 500 kilometers in recent years. It is probable, also, that a part of the tonnage growth and of the shortening of haul results from the inclusion in the data of a larger proportion of the short-haul traffic in recent years. The absence of comprehensive operating statistics, the paucity even of traffic information, and the numerous shifts in coverage and reporting methods all make doubtful the practicability of a detailed study of Soviet water transport. As inland waterways and coastwise operations together account for less than 10 per cent of the total ton-kilometrage in recent years, intensive efforts to augment the data appear inappropriate to this study.

Truck Transport

Freight transportation by motor truck was virtually nonexistent before 1930. It then grew rapidly until 1936 and thereafter maintained a steady level until the eve of war. The prewar level was attained early in 1947, and by 1953 ton-kilometrage had nearly quadrupled, reportedly somewhat exceeding the traffic in the coastwise trade and reaching

approximately one-half that of the inland waterways.[15] The statistics are, however, highly unreliable, particularly those purporting to give ton-kilometers, since estimates of length of haul, especially with less truckload movements, tend to be less reliable than estimates of weight on the vehicles. Purporting to come from the reports by drivers to the Ministry and surveys at check points of a rather small sample blown up to represent the total population, these compilations undoubtedly exaggerate the operations which they are intended to cover.[16] On the other hand, they are probably incomplete, as they appear likely to exclude much trucking which is performed on behalf of collective farms and of industrial ministries in vehicles controlled by those organizations and which is neither reported by drivers nor covered by the check-point surveys. Moreover, the growth of reported traffic has been exaggerated by its increase in coverage.

Enough is apparent from the available data, however, to warrant the complete exclusion of truck transportation from a compilation of Soviet intercity traffic data, just as interplant and local switching movements are excluded from the rail data. For it is apparent that virtually no line-haul transportation by truck exists.[17] Reference to series C-55 will disclose that the average reported haul, probably overstated, has varied over the last fifteen years between 10.4 and 13.2 kilometers. This is primarily traffic of the local cartage variety, performed largely in urban and industrial areas and seldom extending beyond the limits of commercial zones. It is of the type excluded from the intercity transportation data of the United States and of many other countries and of the type about which virtually nothing is known statistically in the United States.[18] It embraces local pick-up and delivery and local distribution services hitherto largely performed by horse dray, but in part substitutes for rail switching moves within terminal areas and over plant railroad systems not a part of the national system. It also embraces rural feeder functions into railheads

[15] See series C-53 for the estimated volume of this traffic.

[16] Soviet methods for surveying motor traffic are similar in principle to those employed by the U.S. Bureau of Public Roads. No detailed investigation of comparative methods has, however, been attempted. A description of Soviet methods is given by E. P. Lebedev, *Transportnaia statistika* [Transportation Statistics], Moscow, 1953, pp. 75 ff, 87 ff.

[17] While the 1946-50 Plan called for the organization of "interdistrict" transport of heavy loads by road and also for an increase of 11,500 kilometers in the network of improved roads, there is nothing in available data to suggest more than occasional truck loads in intercity movement.

[18] The absence of data on other than intercity operations in the U.S. is discussed in Harold Barger, *The Transportation Industries: 1889-1946,* New York, National Bureau of Economic Research, 1951, pp. 221 f.

and rural-to-rural movements which are excluded from available United States data. Truck transportation performs the feeder and distribution role anticipated for it in the United States in the early 1920's.[19]

The limited system of highways and the nearly complete lack of improved highways constitute a serious bar to the development of truck transport.[20] The shortage of petroleum has also stood in the way of its development in the past. As will be observed in Chapter 3, Soviet policy is now to encourage the use of trucks for very short hauls, but to provide sharp incentives for employment of railroads for hauls beyond twenty kilometers. Probably truck transport is more expensive relative to railway in the Soviet Union than in the United States and it should be borne in mind that even in the United States truck transportation is relatively economical only for quite short hauls. From the point of view of resource allocation, the development of long-haul truck transport in the Soviet Union would be an error in other than exceptional circumstances. Yet it should play a role in the opening up of new territory where the volume of traffic early in prospect, while insufficient to justify railroad construction, nevertheless requires overland movement. Extension of the improved highway net will, no doubt, also give rise to a modest intercity truck movement of goods requiring more than usual dispatch, a condition likely to be encountered if a shift toward greater proportions of an increasing variety of consumer goods occurs in the aggregate Soviet output.

Petroleum Pipelines

The pipeline has played an astonishingly minor role in Soviet transportation. Series C-50 through C-52 summarize these results. Not only is the aggregate of minor significance, but the postwar advance over 1940 was, until the last five years, modest, as was the growth in the 1930-40 decade. Comparatively little attention is paid to pipelines in the Soviet transportation literature, undoubtedly because of

[19] To include it in a tabulation for comparison with the United States would slightly inflate the Soviet performance. If, however, value weights were employed, along the lines tested by James Blackman in "Measuring the Volume of Transport in the USSR" (processed, Johns Hopkins Operations Research Office Technical Memorandum 126, Baltimore, 1951), using estimated ton-mile cost of transportation, a serious inflation would be introduced, since Soviet truck transportation appears to be remarkably expensive in comparison with rail and other forms. However, the data on this point are scant and would tend to confirm that the truck transport is of the nature of local cartage in which unit operating costs would be relatively high.

[20] In 1956 there were 1,506,000 kilometers of roads, of which 214,500 were hard-surfaced. Only 47,100 kilometers, however, were cement or black-top surface. See *Transport i sviaz'*, p. 201.

their slight significance up to recent times. Increasing oil production and use, however, are now affording opportunity for further development of the pipeline net, and it is clear from recent discussions and from the Seven Year Plan that considerable pipeline construction is contemplated.

The scant development of pipelines no doubt derives from the small-scale oil production and, more particularly, from its scattered distribution. Economy, compared with rail or water transport, can only be secured when a regular flow can be concentrated into relatively large-diameter pipe. In the United States twenty-four- to thirty-inch-diameter pipe with a capacity for crude of between 220,000 and 300,000 barrels per day appears necessary to attain the economy of the large tanker in coastwise service or of the large integrated tow on the principal rivers. Smaller pipe in the eight- to ten-inch range will achieve an economy approximately that of the railroad, but the flow even in such lines involves a heavy concentration of delivery. Where, therefore, petroleum or petroleum products must be spread out over a vast territory for consumption at low rates at numerous points, economical pipeline transportation becomes impossible to arrange beyond certain break bulk points from which other methods of transportation will have to be employed for distribution. The absence of a large automobile population and the scant farm use of petroleum in the Soviet Union necessitate retail rather than wholesale movements over long distances. In the first stage from the refinery, moreover, maritime and river transport can afford bulk movement to numerous points of transfer to the rail system. It appears that, with increasing petroleum production and an increased density of demand, further pipeline development is anticipated and that this method is coming into favor because of the economy with which it uses materials, particularly steel. Up to the present, however, pipelines have played an exceedingly minor role in Soviet affairs and the railroads have been a correspondingly large factor in total petroleum transportation. Yet, as will appear in Chapter 3, petroleum and petroleum products accounted in 1958 for only 6.9 per cent of rail tons originated, suggesting that petroleum is a much smaller element in Soviet transportation as a whole than is true in the United States.[21]

[21] The Sixth Five Year Plan contemplated virtual replacement of rail transport of petroleum by a considerable expansion of the pipeline system (see *Gudok* [Whistle], March 2, 1956). Yet it is apparently anticipated for 1965 that in spite of marked growth in pipeline traffic, railroad ton-kilometers of petroleum and petroleum-product traffic will rise from 11.8 per cent (in 1958) to 13.6 per cent of total railroad ton-kilometers (see series C-8).

Aggregate Intercity Transportation

Ton-kilometers alone can safely be aggregated to provide a measure of total transportation and, as this datum combines distance with tonnage hauled, it is the most useful traffic statistic for most purposes.[22] Tonnage originated runs the risk of duplication because the same ton may be reported as originated two or more times when it is transferred from one form of transportation to others. No adequate data have been discovered on transfers between forms of transport, although it is known that considerable pipeline and water traffic has a subsequent or prior haul by another form of transport. Transfers between the inland and maritime fleets will even tend to inflate the tonnage originated by water carriers. Soviet transportation is, however, performed so largely by rail that the data on tonnage originated by railroads and its breakdown by commodity groups (discussed in Chapter 3) can hardly fail to be representative of the entire transportation picture and cannot understate the tonnage originated for the transportation system as a whole by more than from 6 to 10 per cent in most years.[23] Rail tonnage originated is, therefore, useful for comparison with production data. Accordingly, although tons originated for each type of transport are shown in the Appendix C, the data relied upon here are metric ton-kilometers which are shown below for selected years for the several types of intercity transport and the total (Table 1, Part A, and Chart 1). These data have also been converted into short ton-miles (Table 1, Part B).

[22] Only ton-miles avoid a double count. Thus a ton moved 500 miles by rail and 200 miles by truck would give two tons originated, but only 700 ton-miles, i.e., total length of haul times the one actual ton involved.

[23] Although rail tonnage originated in the U.S. and the USSR can be compared, tonnage originated data do not exist for U.S. transportation by truck and those for water carriers are of uncertain reliability. While tons handled by truck can be estimated from length of haul for regulated carriers (roughly one-third of the total), no allowance can be made for double counting as a result of multiline truck hauls. Pipeline tons originated include heavy duplication, since the bulk of such traffic moves again by water or truck. The same is true of some rail and truck traffic which receives a prior or subsequent rail haul. The growing piggyback service will produce a double count under piggyback plans I and V, the same ton being shown as a rail ton originated and included in truck tons handled despite continuous movement in a highway semitrailer. Average hauls have been increasing in both countries, but as far as it is possible to make an intelligent guess, the lengthening of hauls is not more rapid in one country than in the other. Thus the representativeness of ton-miles should not have been affected.

TABLE 1

SOVIET FREIGHT TRAFFIC, SELECTED YEARS, 1913-60

Year	Rail[a]	Inland Waterway (powered)[b]	Domestic Maritime[c]	Pipeline[d]	Total	Rail as Per Cent of Total
		PART A: BILLION METRIC TON-KILOMETERS				
1913	65.7	26.2	15.1	0.3	107.3	61.2
1920	14.4	n.a.	n.a.	n.a.	n.a.	n.a.
1925/26	68.9	12.9	n.a.	0.4	n.a.	n.a
1928	93.4	15.9	6.2	0.7	116.2	80.4
1930	133.9	22.9	10.0	2.2	169.0	79.2
1932	169.3	25.1	13.9	2.9	211.2	80.2
1936	323.4	31.1	16.7	3.6	374.8	86.3
1937	354.8	33.0	17.0	3.6	408.4	86.9
1938	370.5	32.0	18.8	3.6	424.9	87.2
1939	391.7	34.6	23.0	3.7	453.0	86.5
1940	415.0	35.8	21.6	3.8	476.2	87.1
1945	314.0	18.3	10.1	2.7	345.1	91.0
1946	335.0	19.9	12.4	3.6	370.9	90.3
1947	350.5	24.4	14.7	n.a.	393.6e	89.0
1948	446.0	30.9	16.6	n.a.	497.5e	89.6
1949	523.8	37.2	19.6	n.a.	584.6e	89.6
1950	602.3	45.5	21.2	4.9	673.9	89.4
1951	677.3	51.0	22.9	5.5	756.7	89.5
1952	741.3	57.1	25.8	6.4	830.6	89.2
1953	798.0	58.6	28.0	7.6	892.2	89.4
1954	856.8	61.7	28.2	10.2	956.9	89.5
1955	970.9	66.6	29.7	14.7	1,081.9	89.7
1956	1,079.1	69.7	31.6	20.5	1,200.9	89.9
1957	1,212.8	75.5	n.a.	26.6	1,346.9f	90.0
1958	1,302.0	84.5	n.a.	33.8	1,452.3f	89.6
1959	1,429.5	92.5	n.a.	41.6	1,595.6f	89.6
1960	1,504.3	98.4	n.a.	51.2	1,685.9f	89.2
		PART B: BILLION SHORT TON-MILES[g]				
1913	45.0	17.9	10.3	0.2	73.5	
1920	9.9	n.a.	n.a.	n.a.	n.a.	
1925/26	47.2	8.8	n.a.	0.3	n.a.	
1928	64.0	10.9	4.2	0.5	79.6	
1930	91.7	15.7	6.9	1.5	115.8	
1932	116.0	17.2	9.5	2.0	144.7	
1936	221.5	21.3	11.4	2.5	256.7	
1937	243.0	22.6	11.6	2.5	279.7	
1938	253.8	21.9	12.9	2.5	291.1	
1939	268.4	23.7	15.8	2.5	310.3	
1940	284.3	24.3	14.8	2.6	326.2	
1945	215.1	12.5	6.9	1.8	236.4	
1946	229.5	13.6	8.5	2.5	254.1	
1947	240.1	16.7	10.1	2.7h	269.6	
1948	305.5	21.2	11.4	2.7h	340.8	
1949	358.8	25.5	13.4	2.7h	400.4	
1950	412.6	31.2	14.5	3.4	461.6	
1951	464.0	34.9	15.7	3.8	518.3	
1952	508.8	39.1	17.7	4.4	569.0	
1953	546.6	40.1	19.2	5.2	611.1	
1954	586.9	42.3	19.3	7.0	655.5	
1955	665.1	45.6	20.3	10.1	741.1	
1956	739.2	47.7	21.6	14.0	822.6	
1957	830.8	51.7	21.9h	18.2	922.6	
1958	891.8	57.9	21.9h	23.2	994.8	
1959	979.2	63.4	21.9h	28.5	1,093.0	
1960	1,030.4	67.4	21.9h	35.1	1,154.8	

NOTES TO TABLE 1

[a] Taken from series C-1, Appendix C. Data are tariff metric ton-kilometers including company material hauled in "commercial" trains. These do not reflect the physical work performed by the railroads as closely as operating ton-kilometers. They do more closely approximate the useful "product," as they come close to representing the service required in distribution within the confines of the existing railroad plant. See the discussion in Chapter 2.

[b] Taken from series C-41. Extensive recourse has been had to estimations based on percentage relationships (see notes to series C-41). For 1956-59, series C-41, col. 2, times ratio of col. 1 to col. 2 for 1955.

[c] Taken from series C-47. Data cover domestic maritime traffic carried in Soviet bottoms. Participation of foreign flags in Soviet domestic traffic was of some significance for a brief period during the early 1930's, but declined after 1936 and disappeared in 1940. Tons originated by foreign flag tonnage exceeded 15 per cent of the total for several years during that period. No ton-kilometers are available, however, for the foreign-flag tonnage. Hence the data for Soviet bottoms only can be employed in this compilation. Data from series C-47 are largely estimated and the notes should be consulted for explanation. See also Appendix B for a general discussion of the problems of estimating Soviet maritime traffic. For 1955-56, derived from the ratio of 1954 estimate to petty cabotage in Table B-10.

[d] Taken from series C-50.

[e] Obtained by assuming pipeline traffic was 4 billion metric ton-kilometers in these years.

[f] Obtained by arbitrarily assuming that domestic maritime traffic was 32 billion metric ton-kilometers in these years.

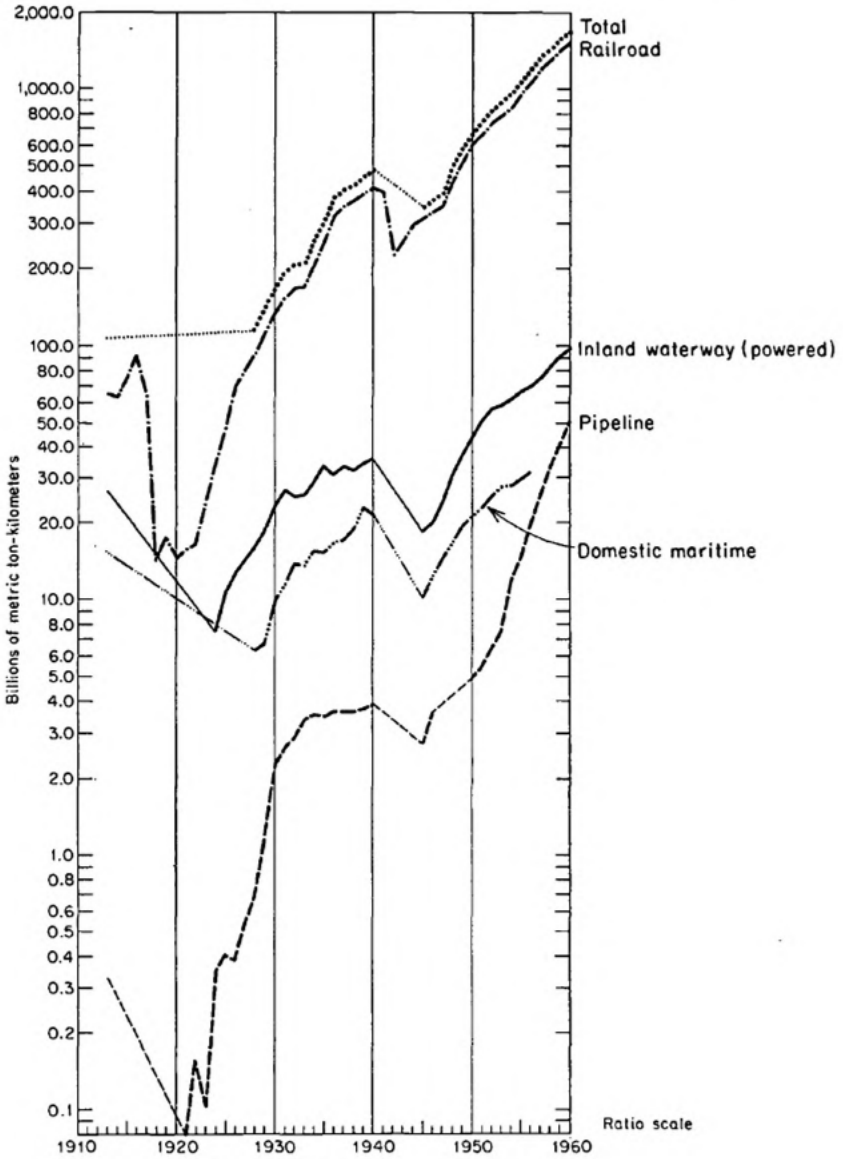
[g] Converted from ton-kilometers at 0.685 ton-miles per metric ton-kilometer.

[h] Assumed to enable a total to be estimated.

NOTE: Changes in concept, of which some have come to our attention and others may not have, deprive these series of complete homogeneity. The rail tariff ton-kilometers, in particular, have been subjected to a change in the postwar period that inflates them somewhat by comparison with the earlier data. This change is discussed in Chapter 2.

CHART 1

Soviet Freight Traffic, Selected Years, 1913-60



Source: See sources to Table 1.

The probable accuracy of the rail series will be discussed at some length in Chapter 2. Suffice it to say that it is believed to overstate actual performance somewhat. While Table 1 probably reasonably reflects the relative movement of traffic by various types of transport from year to year, it should be borne in mind that the data in all likelihood err on the high side. Much more is known about the nature and causes of error in the rail series than in the others. Not enough is known, however, to permit any conclusion on whether the series for one type of transport is more seriously overstated than those for others. Only a qualitative comment is possible on the direction of error.

It will be observed that all intercity freight transportation quadrupled between 1928 and 1940, that the prewar level was attained in 1948, and that by 1954 it had been doubled. Since 1945 a remarkable stability has prevailed in the relationship of rail to other forms of transportation. Even the sharp growth in pipeline volume after 1953 has not greatly disturbed this relationship.

It should be noted that some of the postwar growth in traffic can be traced to expansion of Soviet territory. For years up to 1940, the data in Table 1 are given for the interwar territory; for 1940 on, for the postwar territory. The acquired territories brought about an increase of approximately 7 per cent in railway mileage but they probably had a traffic density somewhat lower than that of the Soviet system in the interwar territory.

Transportation in the United States

Although rail transportation is representative of Soviet transportation today, the same is not true in the United States. Comparisons of the two countries using freight traffic growth as representative of economic growth must be made from aggregates of intercity transportation by all forms of transport (except air which is too negligible for inclusion). A first step is, therefore, to develop the aggregate ton-mile output in the United States in a fashion as nearly comparable with the Soviet coverage as possible. This is difficult because, for some forms of transportation, our statistics are hardly in a better state than those of the Soviet Union and may easily contain biases of as great a magnitude as those that are believed to characterize the Soviet data; nor is the bias likely to be always in a single direction.[24] Moreover, certain of the data have been shifting in coverage over the period we would like to compare and we are unable here to go into all of the qualifications

[24] Only the data on railroads can properly be referred to as statistics.

which surround the estimates for every form of transport except rail, although we shall call attention to them and cite available discussions. Because of the infirmities of estimates for years before 1939, emphasis will be placed upon the period from 1940 to the present, although some much less reliable estimates will be employed for selected years before 1940 because of the great interest of contemporaneous developments in the Soviet Union.

From Table 2 (and Chart 2) on intercity freight traffic in the United States, it appears that, whereas in the 1920's railroads were accustomed to handle well over 60 per cent of the total volume, their share declined rapidly during the 1930's until America's entry into the second war.

TABLE 2

UNITED STATES INTERCITY FREIGHT TRAFFIC, SELECTED YEARS, 1890-1959
(billion short ton-miles)

Year	Rail[a]	Inland Waterways[b]	Coastwise and Intercoastal[c]	Motor Truck[d]	Pipeline[e]	Total	Rail as Per Cent of Total
1890	84.0	19.2	16.6			119.8	70.1
1920	456.2	78.0	59.0		7.0	600.2	76.0
1926	490.8	93.0	158.0	5.0	19.0	765.8	64.1
1928	479.1	86.0	163.0	8.0	26.0	762.1	62.9
1930	423.2	78.0	160.0	12.0	33.0	706.2	59.9
1932	258.0	28.0	131.0	15.0	34.0	466.0	55.4
1936	375.3	86.0	192.0	28.0	40.2	721.5	52.0
1937	398.6	103.0	219.0	35.0	45.0	800.6	49.8
1938	320.2	60.0	202.0	40.0	42.5	664.7	48.2
1939	370.2	96.2	234.7	52.8	55.6	809.5	45.7
1940	411.8	118.1	243.4	62.0	59.3	894.6	46.0
1945	736.2	142.7	117.2	66.6	126.5	1,189.2	61.9
1946	642.7	124.0	229.7	81.7	95.1	1,173.2	54.7
1947	706.7	146.7	206.7	101.7	105.2	1,267.0	55.8
1948	688.7	161.8	210.5	115.5	119.6	1,296.1	53.1
1949	567.3	139.4	214.3	124.9	114.9	1,160.8	48.9
1950	628.5	163.3	233.0	170.2	129.2	1,324.2	47.5
1951	686.4	182.2	251.1	182.5	152.1	1,454.3	47.2
1952	651.4	168.4	248.1	184.1	157.5	1,409.5	46.2
1953	641.8	202.4	264.4	217.2	169.9	1,495.7	42.9
1954	577.5	173.7	270.2	214.6	179.2	1,415.2	40.8
1955	654.8	216.5	278.7	226.2	203.2	1,579.4	41.5
1956	670.2	220.0	274.4	253.8	230.0	1,648.4	40.6
1957	649.4	231.8	268.4	244.9[f]	222.7	1,617.2	40.0
1958	574.8	189.0	n.a.	255.5	211.3	1,500.6[g]	38.3
1959	604.0	196.6	n.a.	288.5	227.0	1,586.1[g]	38.1

NOTES TO TABLE 2

a Revenue ton-miles of Class I, II, and III line-haul railways, electric railways, express and mail, plus nonrevenue ton-miles of Class I steam railroads. Nonrevenue ton-miles of other railroads are not available but are negligible. For 1889, from Barger, *Transportation Industries,* p. 184, adjusted as for 1940. For 1920, 1926, 1928, 1930, 1932, and 1936-38, derived from tons carried one mile by Class I, II, and III railroads as those compared in 1940 with the 1940 datum shown here. Tons carried one mile are from *Statistics of Railways in the United States,* Interstate Commerce Commission, Washington, 1940, Table 155. For 1939-52, from *Intercity Ton Miles, 1939-1952,* I.C.C. Statement No. 544, File No. 10-D-7. For 1953-59, revenue ton-miles (from *Transport Economics,* October 1955, p. 5; *70th Annual Report of the Interstate Commerce Commission,* Washington, 1957, p. 43; *73rd Annual Report of the I.C.C.,* Washington, 1959, p. 11; *74th Annual Report of the I.C.C.,* Washington, 1961, p. 10; and *Intercity Ton Miles, 1939-1959,* I.C.C. Statement No. 6103, File No. 10-D-7) adjusted to the broader concept for 1953 by the relationship which prevailed in 1952, for 1954 and 1955 by the addition of nonrevenue ton-miles reported in *70th Annual Report of the I.C.C.,* p. 43 (source note 1), and for 1956-59 by the relationship which prevailed in 1955.

b Includes the Great Lakes and the intercoastal waterways. For 1889, 1920, 1926, 1928, 1930, 1932, and 1936-38, estimates from Barger, *Transportation Industries,* Table H-1, p. 254. Expansion of the coverage of Corps of Engineers data employed for estimation account for lack of homogeneity between earlier and later years. For 1939-52, from *Intercity Ton Miles, 1939-1952,* Table 2. The data include certain international operations conducted in the United States inland waters. For 1953-59, from *Transport Economics,* October 1955, p. 5; *70th Annual Report of the I.C.C.,* p. 43; *73rd Annual Report of the I.C.C.,* p. 11; and *Intercity Ton Miles, 1939-1959.*

c For 1889, 1920, 1926, 1928, 1930, 1932, and 1936-38, from Barger, *Transportation Industries,* p. 254. Barger's method is substantially similar to that of the Maritime Commission (see Barger, pp. 255-259). For 1939-50, I.C.C. estimates derived from computations of the U.S. Maritime Commission. For 1951-54, estimates of our own made by substantially the same methods, employing data from U.S. Army, Board of Engineers for Rivers and Harbors, *Waterborne Commerce of the United States,* Washington, 1951-54, together with representative distances from U.S. Navy, Hydrographic Office, Table of Maritime Distances. The basic data of the Corps of Engineers present many difficulties of concept, coverage, and overlap. For an analysis of these difficulties, reference may be made to Wytze Gorter and George H. Hildebrand, *The Pacific Coast Maritime Shipping Industry, 1930-1948,* Berkeley, 1952, Vol. I, pp. 71-81. For 1955-57, estimated in *73rd Annual Report of the I.C.C.,* p. 11.

d These data follow the 1952 revision by the Interstate Commerce Commission in which an effort was made to exclude rural-to-rural movement as well as local and suburban delivery by truck. See *Intercity Ton Miles, 1939-1952,* pp. 1-3, for an explanation of the methods used in estimation. Prior to 1939, taken from Barger, *Transportation Industries,* Table F-4, p. 242. Since 1952, from *70th Annual Report of the I.C.C.,* p. 43; *73rd Annual Report of the I.C.C.,* p. 11; *74th Annual Report of the I.C.C.,* p. 10; and *Intercity Ton Miles, 1939-1959.* The surveys on which estimates of the Bureau of Public Roads are based, from which these estimates are derived, are discussed in *Public Roads* (December 1956, pp. 97-98, 102-103), as are statistical methods for choosing and expanding the samples (*ibid.,* pp. 110-117).

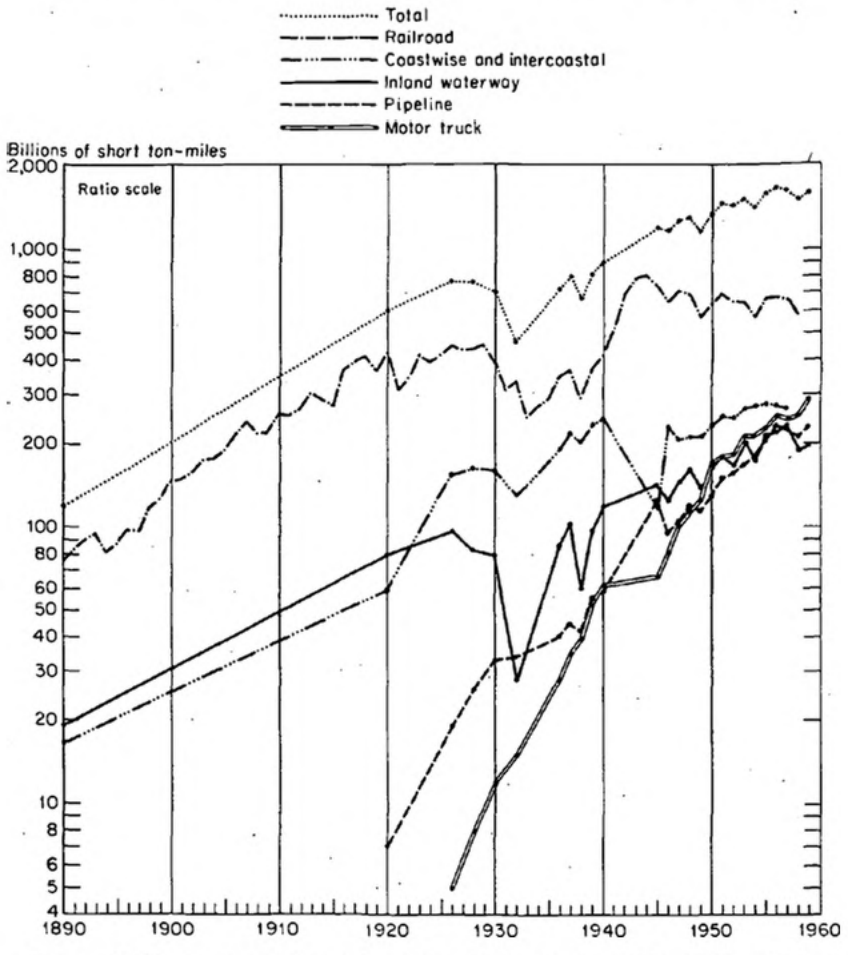
e For 1920, 1926, 1928, 1930, 1932, and 1936-38, from Barger, *Transportation Industries,* Table G-1, p. 251. For later years, from the same I.C.C. sources as cited for motor truck transportation. The estimates by Barger include only pipelines reporting to the I.C.C., hence are less complete than the data shown for later years. The disparity between Barger's estimate for 1940 and the figure here shown is 13.9 billion ton-miles.

f Not comparable with data for other years.

g In order to show a total, coastwise and intercoastal traffic has been included arbitrarily at 270 billion in each year.

CHART 2

U.S. Intercity Freight Traffic, Selected Years, 1890-1959



Source: Table 2, except for railroad freight traffic for 1890-1938, which is from Barger, **Transportation Industries,** Table B-1, pp. 184-185. Those early data have not been adjusted here to include nonrevenue ton-miles, as those in Table 2 were, but the total freight traffic shown here is nevertheless taken from Table 2. The data for 1890-1915 are for years ending June 30, thereafter for calendar years.

By 1940 they handled only 46 per cent of the total. During the war, however, their share increased rapidly and at the end of the war stood at nearly 62 per cent. Since that time there has been an almost uninterrupted decline to a share of less than 40 per cent in the late 1950's.

The rail data employed here are approximately the net ton-miles of all American railroads, for they include nonrevenue ton-miles of Class I carriers. In Chapter 2 we shall have occasion to discuss the proposition that the available Soviet series corresponds most closely to net ton-miles for U.S. roads. However, the Soviet data are tariff, rather than actual, ton-kilometers, a difficulty which will also be discussed in Chapter 2. As there is good reason to believe, from the analysis in the next chapter, that these tariff ton-kilometers are overstated, we have made no adjustment here to place the U.S. data on short-line distances. While the relationship to reported actual ton-kilometers is known approximately, the extent of overstatement is not known for either series although it is believed to be large enough to be of significance. These two differences oppose and at least partially offset one another—perhaps completely in some years. It is likely, however, that the Soviet series overstates in most years the ton-kilometers which are properly comparable with the U.S. series.

It is customary to leave coastwise and intercoastal transportation out of the reckoning in presenting statistics of U.S. transportation. To do so, however, ignores important traffic flows which are of great significance to our domestic economy and which compete with other types of transport; for other resource and movement arrangements would be essential in the absence of these flows, and a large portion, at least, would turn up in other forms of transport. The largest single element of our domestic petroleum transportation is embraced within these data, for nearly the whole coastwise tonnage in recent years is made up by the Gulf-Atlantic petroleum movement. While the hauls in some of these trades are long by comparison with overland routes, the principal trades show only a modest degree of circuity, hence no adjustment has been considered. All the estimates of water transportation volume are subject to a considerable margin of error since no ton-mile data are collected and the Corps of Engineers tonnage data leave much to be desired.[25]

The data on motor truck transportation are estimated, and the estimates have gone through several revisions in recent years. They are designed to show all ton-miles carried by motor vehicles between cities and also between rural and urban areas. They are designed to exclude rural-to-rural movements, city deliveries, and city movements to contiguous suburbs. Estimates by the Bureau of Public Roads

[25] The difficulties with the statistical sources are discussed at length elsewhere and need not be recounted here. See particularly Gorter and Hildebrand, *Pacific Coast Maritime Shipping*, pp. 71-81.

have been adjusted by the Interstate Commerce Commission in an effort to secure this desired coverage of "intercity" traffic.[26] It should be noted that the Bureau of Public Roads estimate is derived from information gathered at test points maintained by the Bureau in order to obtain information on the use made of highways. The representativeness of these estimates has long been a matter of controversy, but they are the only available estimates with any substantial underpinnings of evidence. It will also be observed that these data exclude virtually all motor truck movements of the type which occur in the Soviet Union even though the notion "intercity" sometimes includes movements between political entities which form parts of a metropolitan region in an economic sense. The terminal district concept as administered by the I.C.C. does, however, avoid this difficulty in many of the large urban areas, even bistate ones.

As pointed out in the notes to Table 2, the pipeline data for the years before 1940 are not as inclusive as those after that date. It should be understood that in both periods the ton-miles are estimates based upon barrels moved, estimated weights, and estimated lengths of haul. They are compiled from reports to the I.C.C. of carriers under Commission regulation and from data developed by the Bureau of Mines for nonregulated pipelines. They exclude natural gas lines, but include both crude and products trunk lines and the gathering line system. The growing importance of this method of transportation will be obvious.

The data, when presented in this form, indicate the sharp change in American transportation which has occurred since the 1920's. As the rail share has declined, the representativeness of rail data has also declined. Attention should be focused upon the character of traffic by the various modes of transportation because it has a distinct bearing upon the extent to which rail transport now reflects the aggregate composition of intercity traffic. Unfortunately, data on the composition of truck traffic by commodity and by size of shipment is not available. In 1926, all the water transportation shown was primarily bulk carriage of low-grade commodities, with the exception of a limited tonnage of general cargo handled in the coastwise and intercoastal trades and a very small volume of package freight. The pipeline movement was, of course, bulk. The high-grade traffic moved by truck was a very minor item. It is not likely that traffic in manufactures and miscellaneous categories exceeded 30 per cent of total ton-miles

[26] These adjustments are described in *Intercity Ton Miles, 1939-1952*, pp. 1 ff.

and virtually all of this moved by rail.[27] At the high traffic level of 1953, the situation was in marked contrast to the earlier year. Less-than-carload traffic originated by rail had declined from some 40 million tons in 1926 to a mere 8,255,000 tons in 1953. Manufactures and miscellaneous tonnage originated by rail in 1953 was only 14 per cent higher than in 1926 and its ratio to the total showed very little change. In the interval, however, truck transportation had built up from virtually nothing to 217 billion ton-miles and, while nothing is known directly of the composition of this traffic, what we do know about the character, organization, and regulatory status of truck operators leads us to suppose that more than 70 per cent of this traffic is less-than-carload and manufactures and miscellaneous categories. Water transportation has remained primarily bulk carriage of raw materials, fuels, and staples, changes in the general cargo and package traffic among trades having probably offset one another in large degree. A growing portion of pipeline traffic has, however, been in refined products which has brought it into the manufactured category. It would appear likely, although no satisfactory proof can be afforded, that the proportion of aggregate ton-miles represented by manufactured products, including petroleum, in 1953 was significantly larger than it had been in 1926 and probably represented between 35 and 40 per cent of the total.

When measurement is changed from ton-miles to revenues, the significance of the growth of motor transportation becomes more readily apparent. Revenues of motor common carriers per ton-mile have consistently been more than three times the average ton-mile revenues of railroads, reflecting both the higher quality and shorter average haul of truck freight.[28] Water and pipeline carriers, of course, obtain ton-mile revenues substantially lower than those of railroads. Barger has worked out the freight revenues of the various forms of transportation for 1939:[29]

[27] Rail carloadings were 35.96 per cent in the manufactures and miscellaneous category to which may be added the less-than-carload tonnage. Ton-miles are not available by class of traffic, but tons originated in these two categories represented 28 per cent of total rail tonnage originated, and, as the average haul is longer for these than for other groups, rail ton-miles in these categories may be supposed to have exceeded 30 per cent of total rail ton-miles.

[28] However, average truck hauls for Class I regulated carriers have approximated 200 miles in recent years.

[29] Barger, *Transportation Industries*, pp. 15, 128.

Electric and steam railroads	$3,317,000,000
Intercity for-hire trucking	887,000,000
Pipelines	188,000,000
Waterways	463,000,000
Total	$4,855,000,000

Charles Taff has developed estimates for 1951 and 1955 which cover passenger and freight transportation combined, but from which we may extract certain approximations of intercity freight transportation:[30]

	1951	1955
	(million dollars)	
Steam and electric railroads	8,860	8,790
Common and contract truck	4,169	
Total, intercity truck		12,900
Pipeline (petroleum)	655	846
Water carrier	1,930	2,659
Total	15,614	25,195

Thus it appears that rail freight revenues have declined from 69 per cent of the total in 1939 to 56 per cent in 1951. But this is far from a complete picture, for the truck revenues shown here represent approximately 37 per cent of the intercity movement covered by our ton-mile estimates while they include certain local operations excluded from those data. As Class I motor carriers of property reporting to the Commission in 1951 already had average ton-mile revenues exceeding five cents, it is reasonable to use a figure of four cents a ton-mile for the entire intercity truck traffic. If this is done, we obtain $7,300 million of truck revenues and a total for all transportation of $18,745 million. By 1953 truck revenues should have passed rail freight revenues and should have accounted for approximately 43 to 46 per cent of all intercity freight revenues. This situation is emphasized by Taff's 1955 estimates which attempt to reflect all intercity truck transportation. Upon this basis, rail freight revenues were less than 35 per cent of all freight revenues. These value data demonstrate the extent to which the United States has become dependent upon the truck for its high-quality transportation—predominantly the movement of small-lot consignments and of finished and semi-finished manufac-

[30] Charles A. Taff, *Traffic Management: Principles and Practices*, rev. ed., Homewood, Ill., 1959, p. 3.

tured items, although the substantial truck movement of perishables and other agricultural commodities in exempt transportation should not be forgotten.

Comparisons of Soviet and United States Traffic

To compare Soviet and United States aggregate freight traffic, it is necessary to convert the data to a common unit of measure. Because the short ton-mile is a measure more congenial to American ways of thinking than the metric ton-kilometer, we have converted Soviet data into short ton-miles. The results are presented in Table 3 and Chart 3.

TABLE 3

UNITED STATES AND SOVIET TOTAL FREIGHT TRAFFIC, SELECTED YEARS, 1890-1959
(billion short ton-miles)

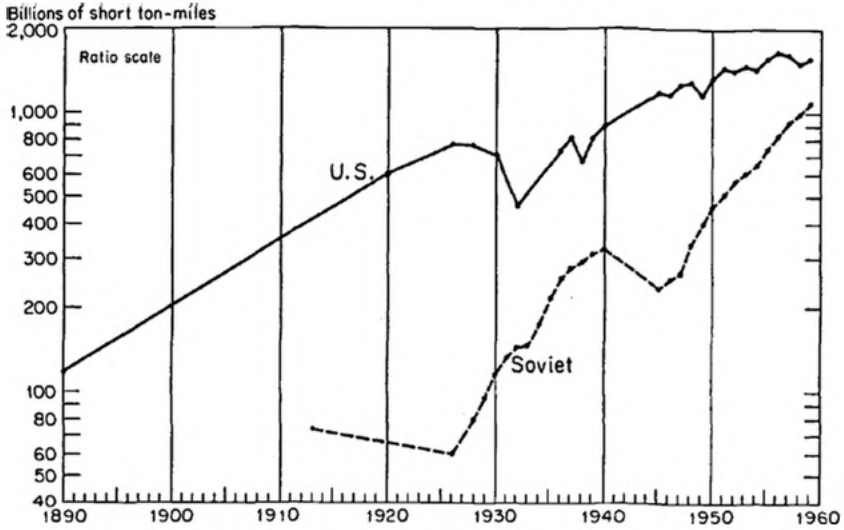
Year	U.S. Traffic	Soviet Traffic	U.S. as a Multiple of Soviet Traffic	Excess of U.S. over Soviet Traffic
1890	119.8	n.a.		
1913	n.a.	73.5		
1920	600.2	n.a.		
1926	765.8	60.4[a]	12.7	705.4
1928	762.1	79.6	9.6	682.5
1930	706.2	115.8	6.1	590.4
1932	466.0	144.7	3.2	321.3
1936	721.5	256.7	2.8	464.8
1937	800.6	279.7	2.8	520.9
1938	664.7	291.1	2.3	373.6
1939	809.5	310.3	2.6	499.2
1940	894.6	326.2	2.7	568.4
1945	1,189.2	236.4	5.0	952.8
1946	1,173.2	254.1	4.6	919.1
1947	1,267.0	269.6	4.7	997.4
1948	1,296.1	342.2	3.8	953.9
1949	1,160.8	400.4	2.9	760.4
1950	1,324.2	461.6	2.9	862.6
1951	1,454.3	518.3	2.8	936.0
1952	1,409.5	569.0	2.5	840.5
1953	1,495.7	611.1	2.4	884.6
1954	1,415.2	655.5	2.2	759.7
1955	1,579.4	741.1	2.1	838.3
1956	1,648.4	822.6	2.0	826.4
1957	1,617.2	922.6	1.8	694.6
1958	1,500.6	994.8	1.5	501.8
1959	1,586.1	1,093.0	1.5	493.1

SOURCE: Tables 1 and 2.

a For 1925/26. For purposes of this comparison, maritime traffic is assumed to have been 6 billion ton-kilometers in 1925/26.

CHART 3

Comparison of U.S. and Soviet Total Freight Traffic, Selected Years, 1890-1959



Source: For U.S., Table 3; for Soviet Union, derived from sources given in Table 1 and converted into short ton-miles (at 0.685 ton-miles per metric ton-kilometer).

It will appear from Table 3 that while transportation in the United States more than doubled between its pre-World War II peak in 1926 and its peak to date in 1956, Soviet transportation increased twelve times in the equivalent period. Yet in 1956 the United States was still transporting more than twice as many ton-miles of freight as the Soviet Union, without even taking account of the fact that the United States product is probably understated,[31] and the Soviet product overstated, a matter that will be discussed in the following chapter. During this period, moreover, U.S. traffic grew by 820.3 billion ton-miles while Soviet traffic grew only 762.1 billion. Soviet transportation was nearly 30 per cent below the 1940 level in 1945, but by 1954 had attained slightly more than double the 1940 volume. The United States, however, which experienced a growth during the war, had by 1953 moved up to 166 per cent of the 1940 level, and then experienced a

[31] This applies particularly to intercity truck transportation, since it is believed that a portion of the vehicles escapes Bureau of Public Roads stations under the misapprehension that they are state weighing stations. It may apply also to certain elements of water transportation because the ton-miles are estimated from what are believed to be representative distances which may well understate distances over the routes of movement, especially where outports are served.

modest decline. This decline was more than made up for in 1955 and a further increase occurred in 1956. Since then, the volume has decreased, although a resumption of traffic growth now appears to be in progress.

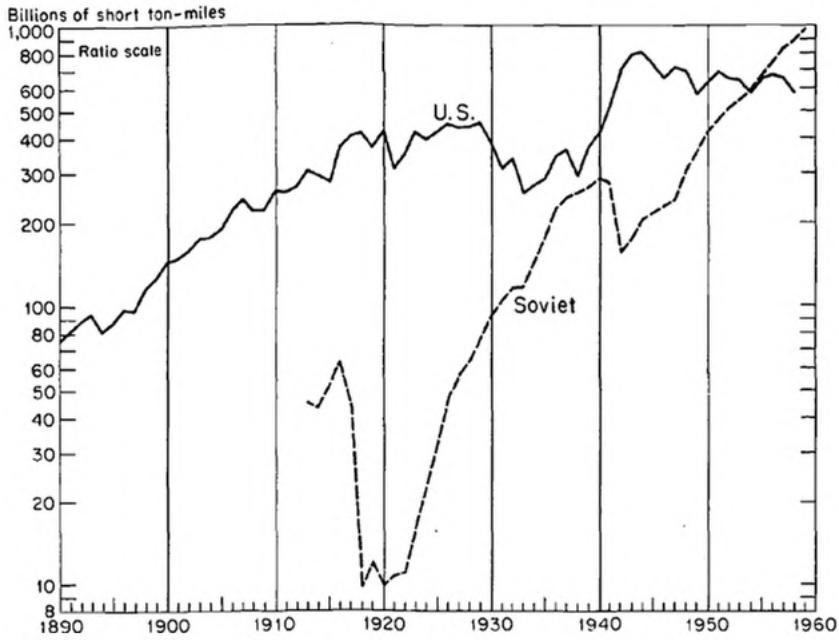
Over the decades covered in Table 3, it was never necessary for U.S. freight traffic to grow as rapidly as Soviet freight traffic has, except for the brief acceleration to the wartime peak. It is worth noting, however, that the American rail plant, without increase of mileage and with a shrinkage of total available trackage, without significant increase of its freight car fleet, and with only limited additions to its motive power, was able to handle by 1944 more than two and a third times the volume of 1938. With substantially less plant and equipment than in 1926, the 1944 performance was one and a half times the previous peak volume of 1926. In no small measure the ability of the American rail system to accomplish so large an increase in ton-miles in such a short space of time is the result of the transition from peacetime to wartime conditions, which makes possible changes in operation conducive to more intensive utilization. "Normal" Soviet conditions, as will be observed later, are more akin to wartime than to peacetime conditions in the United States. But in considerable part the wartime experience also reflects the fact that the American railway system has, over the years, carried a good deal of excess capacity in its main running lines and terminals.

The effect of the depression of the 1930's, reflected in the decline of U.S. traffic while Soviet traffic continued to grow, is apparent in Table 3. The rapid wartime expansion in the U.S. and the contemporaneous contraction in the USSR resulted in U.S. excesses over USSR freight volume approaching a trillion ton-miles in each of the first four postwar years. Only a modest reduction in this excess occurred until after 1956 when the U.S. experienced a decline in traffic volume.

The brief discussion so far has compared Soviet and American developments over concurrent periods. This involves comparing growth in the relatively large American industry with growth in the relatively small Soviet industry. Rapid rates of growth characterized transportation in the United States at earlier periods in its history. Since extensive data are not available for total transportation during those earlier periods, recourse must be had to railroad data alone as a means of appraising relative rates of growth. As an approach to these comparisons, we may recast Soviet railroad ton-kilometers and compute index numbers using various base years to compare rates of growth

CHART 4

U.S. and Soviet Railroad Freight Traffic, Selected Years, 1890-1959



Source: For Soviet Union, series C-1 in Appendix C converted into short ton-miles. For U.S., see Chart 2.

TABLE 4

SOVIET RAILWAYS, INDEX NUMBERS, SELECTED YEARS, 1913-54

	1913 Base	1926 Base	1940 Base	1948 Base[a]
1913[b]	100			
1925/26	105	100		
1930	204	194		
1935	393	375		
1940	632	602	100	
1948	679		107	100
1950	917		145	135
1952	1,128		179	166
1954	1,304		206	192

SOURCE: Table 1; 1935 from series C-1 in Appendix C.

NOTE: It should be observed that moderate territorial expansion, for which we have been unable to adjust, entered at several points (see Chapter 2). There is also reason to suppose that the overstatement of ton-kilometers may have increased as a percentage of the whole, particularly in the 1930's, which would exaggerate the rate of growth. The evidence is, however, far from conclusive; hence it is undesirable to make any assumptions on this point. The ton-kilometer series, as observed above, is not entirely homogeneous because of several changes of concept.

a This is of interest as a base year since it represents the first postwar year in which the 1940 volume of freight traffic in ton-kilometers was surpassed.

b Interwar territory.

with those during various periods in American railroad history (Table 4; see also Chart 4). Thus, from the level achieved in 1913 before the revolution, Russian rail freight traffic multiplied thirteen times over the forty-one years through 1954. Soviet rail traffic first exceeded U.S. rail volume in that year and it has remained ahead in all subsequent years. By comparison, United States traffic multiplied 11.4 times from 1882 through 1923; 10.2 times from 1885 through the 1926 peak; five times from 1889 through 1930, which was a year of depressed traffic; and 3.8 times from 1904 through the all-time peak of 1945. Data for all United States railroads are not available before 1882.

Comparisons of the Soviet 1926-40 experience may be made with traffic growth in ton-miles on United States railroads at five-year intervals for various periods of rapid growth as follows:[32]

	U.S.					
Soviet 1925/26 Base	1890 Base	1893 Base	1894 Base	1895 Base	1898 Base	1903 Base
100	100	100	100	100	100	100
194	112	122	154	166	152	126
375	186	185	217	219	191	174
602	245	233	272	299	264	236

Thus it appears that the most rapid growth over a fifteen-year period in the recorded history of American railroads was from 1895 to 1910 when the volume nearly tripled.[33] However, it appears from the Babson estimates of ton-miles, which antedate the Interstate Commerce Commission statistics, that in the period 1877-81 American railroad ton-miles more than doubled in the space of four years.[34] Between 1885 and 1888 the increase was by approximately one-half. Both of these periods represent increases from the low points of depressions and both were accompanied by a rapid increase of line mileage—indeed they were two of the most vigorous periods of railroad building and of westward expansion in American railway history. The rates then achieved were not sustained over long periods. Nor can the Babson estimates be meshed with the I.C.C. figures to enable us to span the periods before and after 1889 with confidence. However, it may be observed that the growth beween 1890 and 1920 was not quite sixfold. After 1918 growth was at a considerably slower rate than in the period from 1890 up to that year.

[32] All U.S. data for the period before 1940 are for Class I, II, and III railroads, revenue ton-miles only, as reported by the I.C.C.

[33] The Interstate Commerce Commission statistics begin with the year 1889.

[34] See Thor Hultgren, *American Transportation in Prosperity and Depression*, New York, NBER, 1948, p. 24.

Soviet postwar traffic growth, since the re-establishment of the prewar level, has been slower than during the prewar period. It has had no parallel in recent American history, for either rail alone or transportation of all types (Table 5). Hence some indexes of railroad

TABLE 5

UNITED STATES AND SOVIET POSTWAR GROWTH OF FREIGHT TRAFFIC, INDEX NUMBERS

	Soviet Rail		*U.S. Rail*		*U.S. All Transportation*	
	1940 Base	1948 Base	1940 Base	1948 Base	1940 Base	1948 Base
1940	100		100		100	
1948	107	100	167	100	145	100
1950	145	135	152	91	148	102
1952	179	166	158	95	158	109
1954	206	192	140	84	155	107[a]

SOURCE: Tables 4 and 2.

[a] 1954 was a year of depressed truck and rail traffic. For 1955, the ratio on the 1948 base was 118, while for 1953 it stood at 114.

growth at earlier periods of U.S. history are also offered at two-year intervals for comparison with the span in Soviet development from 1948 to 1954 (Table 6). Again it is necessary to return to the period before 1889 to find growth rates in short periods on American railroads which duplicate the Soviet postwar period.

TABLE 6

SOVIET POSTWAR GROWTH OF RAIL TRAFFIC
COMPARED WITH OTHER PERIODS IN THE UNITED STATES, INDEX NUMBERS
(two-year intervals)

	U.S.			
Soviet 1948 Base	1894 Base	1898 Base	1908 Base	1921 Base
100	100	100	100	100
135	119	125	117	134
166	142	138	121	135
192	176	154	132	139

SOURCE: Table 4 and footnote 32.

As will be elaborated in later chapters, the Soviet growth is a real one, even though our indexes may overstate it to some degree. It represents, moreover, a very solid accomplishment. Except for a brief period in the middle 1930's, no substantial evidence has come to light which suggests that Soviet transportation inadequacies have in any material way limited the growth of other segments of the economy, although it is clear that Soviet industry labors under the burden of adjusting its operations to limited transportation capacity in ways unknown in the Western world. Four decades of intensive development of a limited rail network with a highly intensive use of the physical plant appear not to have diminished the capabilities of transport in relation to the economy as a whole. The period has been one of struggle to keep abreast of traffic, however. There has not been significant concentration on service improvement. The emphasis now appears to be shifting toward modernization of plant and equipment which, however, Soviet writers concede will be a slow process as theirs is a rapidly expanding railroad economy. That there are but limited reserves in the transportation system is very probably correct, yet if this should also be true of the Soviet manufacturing industry, then the risk may be a limited one. Nevertheless, the recent literature suggests growing concern lest the postwar transportation expansion not keep pace with the demands of the economy and lest this failure again obstruct growth in other sectors. Hence the emphasis is on further expansion, but with an economy of investment to be made possible by large-scale electrification and dieselization.

The rationale behind such proposals as embraced in the Sixth Five Year Plan was made clear by Blackman in his study of locomotive technology,[35] and the same policies appear to be reflected in the current Seven Year Plan for the years to 1965. Essentially they represent a logical continuance of earlier policy for, by shifting to diesel power, it will be possible to handle heavier trainloads at greater speeds over existing lines, thus increasing the output of which these lines are capable. Although passing sidings and receiving and departure yard trackage may require lengthening, the light axle loadings of diesel power will avoid the necessity for large-scale replacement of rail with heavier section as well as the necessity for extensive bridge strengthening or replacement. Both these types of rebuilding would be required were more intensive working sought through the use of heavier steam power. Hence although the Soviet calculations promise

[35] James H. Blackman, *Transport Development and Locomotive Technology in the Soviet Union*, Columbia, S. C., 1957.

operating economies analogous to those realized in this country, primary interest appears to be focused on the saving in capital investment associated with a given increase in capacity. This gives dieselization a dimension which was rarely of significance in the U.S.[36]

[36] Difference in the quality of transport output might, of course, be reflected by comparisons in value terms rather than in ton-miles. Since the Soviet output is virtually all performed by rail, water, and pipeline transport, and since the principal change over the years has been the increase in the rail share to nearly 90 per cent, a properly constructed index of values ought to show a growth not very different from that in ton-miles. In the United States, despite great changes in the participation of various types of transport, the discrepancy between output measured in value and that measured in ton-miles appears to be less than might be expected. For while the 1955 volume was slightly over twice the 1929 volume, estimated freight revenues were less than two and a half times the 1929 level. Yet U.S. performance compared with USSR performance would probably appear somewhat stronger in value terms than in tons or ton-miles, as used here.

CHAPTER 2

Soviet Railroad Traffic

Statistical Measures

The principal statistical measures of railroad freight traffic for the Soviet Union are available, or can be approximated from the reported relationships of available data to other years, for the whole Soviet period and for the base year 1913, except for some years for which interpolation has been resorted to in some series. More doubt surrounds the data for the period of World War I and the subsequent civil war than for the later years before World War II. Scant evidence is available for the war years, but a relative abundance of material on the immediate postwar period is available, together with substantial detail for the last decade.[1] Moreover, there are difficulties of territorial coverage, particularly during the revolutionary period, when the effort to assemble statistics from reports of the several railroad administrations after the event results in gaps as well as doubt on the portion of traffic covered. Limited significance should be assigned to the data for 1916-20. At a later period, difficulty is encountered in allowing for absorption of the lines in eastern Poland because it is impossible to segregate the Polish railway traffic data for the prewar years. On the whole, however, the available data give a general view of the aggregate output of the Soviet rail plant in familiar terms, viz., metric tons originated, carloadings, and metric ton-kilometers (at least two of these series are subject to a probable overstatement). In the study of all series, care should be taken to observe the years when territorial coverage changes.

The student familiar with Western rail statistics is at once confronted with the necessity of understanding precisely what the Soviet data purport to show. He must beware of direct comparisons with Western data which are derived in some instances from different documentary sources, may be designed to serve somewhat different purposes, and are compiled under accounting concepts that are sometimes more rigorously applied and policed. The concept of tons

[1] The reader should be cautioned to read with care the introduction to Appendix C. An effort has been made not only to secure the Soviet statistics, but also to fill out the series with the most probable estimates in the absence of direct Soviet data. As will appear, the statistics, even when available, frequently misrepresent the facts or differ in concept or in coverage from U.S. series which are nominally similar.

originated does not appear to differ from that employed in this country, except that double counting does not seem to be positively avoided in the case of tonnage first loaded on rail cars, subsequently transferred to a water haul, and later reloaded on railroads. The Soviet literature appears to contain little discussion of such rail-water-rail movements, but it is apparent that, although a certain amount of such traffic existed on river and maritime routes in the early 1930's, efforts to stimulate these joint hauls have not been as successful as desired and they represent very small tonnages in relation to total rail freight. Similarly, the carloadings appear to be analogous to those compiled by the Association of American Railroads rather than those published by the Interstate Commerce Commission. The latter refer to carload traffic only (including forwarder traffic) and treat through rail-water-rail movements as though they were continuous carload movements, which are represented by a single car count at the initial rail origin. One difference between the Soviet system and that of the Association of American Railroads is that cars received from connecting lines of other countries are recorded as carloadings in the USSR. This is believed to represent a relatively small element, but to the extent that it exists it tends to overstate Soviet loadings in comparison with those of the United States, especially for recent years.[2] Volumes of traffic between the USSR and the satellites to its west as well as Red China have certainly grown considerably.

The Soviet carloading data are, however, given in two-axle units rather than in actual cars since the mixed fleet composed of two-axle and four-axle cars requires a common denominator.[3] Moreover, tank cars are weighted by nominal weight capacity on a scale which disregards the actual number of axles in cars of more than two axles. Thus, up to nineteen tons capacity, they are counted as one conventional unit, twenty to twenty-five tons as two such units, twenty-six to forty tons as three, and over forty tons as four. Hence Soviet load-

[2] This same lack of comparability probably exists for the data on tons originated. It was reported in late 1959 that traffic between Eastern Europe and China across the USSR is now a complicating factor.

[3] Like railroads in other parts of the world, the Soviet system has a few heavy-duty cars carried on more than four axles for oversize and exceptionally heavy single-piece shipments. Some three-quarters of the Soviet cars are now four-axle ones, largely of design similar to some common in the United States in the late 1920's. The European type of two-axle car still makes a substantial contribution to Soviet rail traffic performance not only because of its number, but also because it is adaptable to small carload shipments, and hence it is not to be regarded as entirely obsolete. Moreover, the two-axle car usually has greater cubic, in comparison to weight, capacity than four-axle cars—a factor which helps attain a high load factor with this type of equipment.

ings as reported should be reduced by one-half to secure a series roughly comparable to that of the Association of American Railroads for the United States. It is further to be noted that the Soviet system reports average daily carloadings, whereas the custom in the United States is to report aggregate carloadings weekly, quarterly, and annually.

A less obvious, but more important, difference must be noted in the ton-kilometer data. As ton-kilometers reflect both the tonnage loaded and the distance over which it is moved, they afford the best measure of a carrier's freight traffic performance. Moreover, in view of the transfers from one type of transport to another which give rise to duplications in tons originated data—each form of transport treating the traffic as originated when received even though delivered by a connecting carrier of another type—ton-kilometers alone can be aggregated to secure a measure of the complete freight traffic output of a transport system. The Soviet system reports two series for ton-kilometers. One, which they call "tariff" ton-kilometers, is more regularly reported in absolute figures in Soviet publications. The second, which they call "operating," purports to be actual ton-kilometers.[4] Tariff ton-kilometers are not a direct measure of the physical work produced by the railroad system. In effect they record the ton-kilometers that would have been produced had the traffic in all instances moved over the short tariff routes or the routes approved for plan purposes.[5] They do not record the ton-kilometers produced when traffic actually moves over routes other than the short tariff or plan routes.

[4] It is hoped that the tariff series is a homogeneous one, representing tariff ton-kilometers computed from originated waybills (waybills at the point of issuance). But it appears probable that terminated waybills (waybills received at destination stations representing completed shipments) are used in the postwar period. An alternative system records short tariff distances between each junction stamp on the terminated waybill. For any given time period, there is a different population of waybills employed in these two computations. The terminated bills are apparently used for division of revenues among the several railroads. Alternatively these two statistics may be called "revenue" and "performed," respectively.

[5] These data are compiled from the freight waybills on which the station agent at origin enters the tariff distance (the shortest physical route regardless of practicability as shown in Tariff Handbook No. 4 via prescribed or approved junction points between railroads). Junction points for routing purposes may be altered in successive semiannual plans for the making of trains or by order of the ministry. Internal routing on any railroad may differ from the mileage entered on the waybill. On certain routes terminal arbitraries (distances arbitrarily established regardless of the actual distances) are employed, as in the case of Moscow where fifty-four kilometers are added to all through routes representing one-half the length of the belt line (*Kratkii tekhnicheskii zheleznodorozhnyi slovar'* [Brief Technical Railroad Dictionary], Moscow, 1946, p. 507).

The United States statistics show the ton-mileage actually performed over the route of movement. Moreover, the Soviet concept of a short tariff route does not exactly correspond to the similar concept in the United States as defined by the Interstate Commerce Commission in prescribing rate scales. Our rate-making distances are not necessarily the shortest routes over which traffic can be moved without transfer of lading, although they tend to approximate such distances. Regardless of changes in actual routing practices, these rate-making distances remain undisturbed except by changes in the physical plant. The Soviet tariff distance, however, purports to represent the shortest route between any two points over which traffic can be worked via the specified junctions. The relative simplicity of the Soviet system of lines, as well as its organization into regional groups of lines, eliminates the problem of a variety of competing multiline routes. Insofar as the tariff ton-kilometers are computed from the originated waybills in a given time, in a period of expanding traffic they tend to overstate the annual ton-kilometers by as much as three to four days' traffic.[6]

A second difficulty, which applies to both the Soviet ton-kilometer series, is that they include company material moved in "commercial" trains, though they exclude the movement of such material in nonrevenue trains. Hence they are not comparable with the revenue ton-mile series for United States roads, nor are they quite comparable with our net ton-miles, revenue and nonrevenue. This last fact results, however, from different relationships in the movement of company material in work and special trains, the Soviet system having a relatively larger movement in such trains. The nearest comparison is, therefore, with our revenue and nonrevenue net ton-miles, and for most purposes this will suffice.[7] It should be noted, however, that since it has not been possible to separate out the company material

[6] U.S. railroads formerly used the waybill method for computing ton-miles, but because of the resulting overlap and the delays pending a closing out of interline waybills, the use of conductors' wheel reports was required by the U.S. railroad administration during the first war (see J. L. White, *Analysis of Railway Operations*, 2nd ed., New York, 1946, pp. 229 ff). This had the effect of recording in any period the ton-miles actually performed in train service. Most American railroads maintain their revenue accounts, however, on a received basis (see E. H. Bunnell, *Railroad Accounting and Statistics*, Chicago, 1955, p. 34).

[7] Certain minor differences no doubt result from a lack of common treatment. Thus Item 63 in Rail Form A, annual report to the Interstate Commerce Commission, includes a proportion of the weight of exclusive work equipment based on the relationship of net ton-miles to gross ton-miles for the reporting period, a wholly arbitrary inclusion. The same item includes water transfer service on the Great Lakes involving a rail-line haul, the revenue from which is includible in Account No. 101. We are unable to ascertain in similar detail the specific content of the Soviet series.

from the Soviet series, this series includes not only the traffic hauled for shippers, but also most of the tonnage hauled for the maintenance, construction, and working of the railroads, and should not be mistakenly compared with the revenue ton-miles of U.S. roads. Since the Soviet system until recently has operated primarily on steam (which requires much larger tonnages of fuel than does diesel power for an equivalent performance), since the state of its locomotive technology must result in a rather high consumption of coal per thousand gross ton-kilometers, and since the haul of company material undoubtedly averages longer than that in the United States, a larger proportion of the ton-kilometers no doubt represents traffic required to meet the needs of the railroads themselves than is the case in the United States.

We have been able to develop a less complete and a much less certain series for operating ton-kilometers. Were the series as soundly based on published Soviet data as the tariff ton-kilometer series, and were the Soviet data based upon documents as well supervised as our conductors' wheel reports, it would certainly afford the most accurate measure of the actual physical work of the Soviet railway system. For it is derived from engineers' trip reports which purport to show actual net ton-kilometrage, including the differences between the route of movement and the tariff route and between actual origin or destination and the nearest agency station from or to which the traffic is billed. Hence it corresponds in concept closely to our net ton-miles, revenue and non-revenue, and is derived from a similar primary document. Unhappily a wide variety of evidence suggests frequent falsification of engineers' trip reports in the direction of overstatement.[8] As the disparity between the two ton-kilometer series has been rather steadily reduced and now is of the order of 1 per cent, it may be that these inaccuracies have been brought under control. Direct data are available for 1930-38 and 1940. The relationship of operating to tariff ton-kilometers is given for certain other years and permits a direct computation. Since a great effort is made to reduce the disparity between the two series—the excess of operating over tariff ton-kilometers being commonly regarded by Soviet administrators as "wasteful" transportation—the movement upward or downward in particular years is frequently given

[8] Audit practices appear to be loose. Crews have incentives to overstate the tonnage of trains in order to overstate gross ton-kilometers and thus benefit from the premiums paid for fuel economy. Instances are recorded of the train tonnage being reported separately in total by each engineer of a double-headed train. *Gudok*, the newspaper of the Ministry of Transportation, from time to time cites such cases which probably are but samples of a widespread practice. Kochetov attributes some of the excess of operating ton-kilometers to engineers' overstatement of tonnage.

in percentages.[9] The use of percentage relationships so far removed from the desired datum of course introduces large possibility of error in the result. Interpolation has also been necessary to fill out the series.

The question arises, in connection with the traffic statistics, whether the pressures which assail Soviet shipping industries and Soviet railroad administrators may result in misrepresentation which produces an upward bias. This is a particularly vital question because of the usefulness of accurate traffic statistics as a measure of economic growth. No entirely satisfactory answer has been obtained and in the end it is necessary to rely on judgment in appraising probable reliability. We are inclined to regard the tariff ton-kilometers as a reasonably accurate representation of the facts which they purport to convey, subject to a moderate upward bias which we are unable to estimate since Soviet authorities themselves are unable to put a value upon it.[10] It has been suggested that the billed tonnage may exceed that actually loaded in view of the emphasis placed upon heavy carloading and the penalties which may be brought to bear on shippers for the misuse of rolling stock, and this suggestion appears to have merit. The high performance recorded for average carload and average car turnaround between loads tends to support this view. Perhaps the tendency merely counteracts the tendency, present in all countries, to underbill in order to reduce charges, but the tenor of official statements suggests a considerable lack of concern about freight charges on the part of Soviet industry.

The quarterly plan procedure, with its monthly breakdown, represents a cooperative endeavor between shipping ministries and the Ministry of Transportation and its railroad administrations to establish norms for static carload which govern the supply of cars to individual shipping installations. To be sure, there is evidence of negligence in plan enforcement as well as in the planning process itself, but nevertheless the plan must have some influence. Moreover, the loading norms for various commodities appear to be well adjusted to the loading capacities of cars and are, in this sense, practical. Yet penalties

[9] Some of the disparity is, of course, unavoidable. Overemphasis on the short routing of traffic may also result in congestion of the direct lines and in less efficient use of equipment where the movement is slower or faces greater physical obstacles than via less direct routes. Little attention appears to be given to these factors which influence much internal routing in the United States, although they undoubtedly affect daily operation. Soviet analysts are aware of them, but the overemphasis of simple objectives on occasion encourages inefficiency.

[10] As will appear, there are numerous instances of bias in the Soviet statistics which tend to reinforce one another and the recognition of which promotes a better understanding of rail performance, even though the degree of bias cannot be determined.

for ordering more cars than can be loaded are relatively low, while the pressures to be certain of an adequate car supply are great. Over-ordering of cars appears to be a fairly common phenomenon which provides both opportunities and incentives for light loading and over-billing to conceal this departure from efficient practice.

We have discovered no Soviet equivalent of the weighing and inspection bureau or of other checks on the accuracy of shippers' scale weights and billed weights. Reliance seems to be put primarily on weighmasters and station agents. An annual sample weighing of some 300,000 cars is made at check points. Industry scales under the supervision of railroad test forces appear to exist very rarely and the evidence suggests that a great part of Soviet rail traffic is billed and moves without a scale weight being taken. Much bulk traffic moves on estimated weights derived from a rough approximation of the cubic space occupied multiplied by the average weight of the commodity per cubic meter. Visual inspection of open-top cars thus loaded provides a rough check on whether they are well or lightly loaded, but can be highly deceptive when a wide range of commodities is involved and when the inspection is made at different points in transit.[11] In any event, the results of the sample weight checks disclose a consistent overstatement of actual weight in the billed weight from which statistics are compiled. The degree of overstatement is reported to average from one-half to three tons per car.

Given an overstatement of tonnage in the waybills, not only tons originated but also tariff ton-kilometers are overstated. There seems to be little likelihood of consistent or important overstatement of tariff distances since the compilation from destination waybills, on which the route is recorded by stamps at origin stations, junctions, and destination stations, affords an audit check on proper application of the published table of shortline distances. In most respects, however, the internal audit system has not been investigated. Elsewhere we will discuss the evidence available from the operating statistics which lends credence to the recorded traffic performance.

Growth of Soviet Rail Freight Traffic

The Soviet railroads began to show firm signs of recuperation from war and revolutionary conditions in the fiscal year 1922/23, but it was not until 1928, after steady growth, that the 1916 volume was exceeded.

[11] Loads of coal and other bulk commodities tend to consolidate after they have been in motion for some time and appear less well loaded at destination than at origin.

Contemporary accounts by foreign observers record both the disorganization prevalent in 1921 and the slow steps toward recuperation,[12] which took effect with more firm administration in 1923,[13] although physical rehabilitation presented problems which could only be coped with gradually and required substantial import of technical personnel, motive power, rolling stock, and other equipment.[14] This importation has had lasting effects on Soviet railroad technology and operating practices and may well account, in lieu of the designed initiative of the Soviets, for the adoption of features characteristic of U.S. technology. The Soviet discussions refer to their policy, however, as an effort to adopt the best of West European and United States practices. This appears to be largely a rationalization for the long continuance of a mixed technology, although some arguments can be found for continuing in service a proportion of European-type equipment.[15]

An annual growth of 20 billion ton-kilometers after 1928 slowed down in 1932 and came to a halt in 1933, producing the "transportation crisis" of the early 1930's which has been the object of considerable attention by analysts in the English-speaking world. Retardation of the rate of growth, of course, accompanied the fairly steady absolute growth in the late 1920's and in 1930 and 1931. Equipment importations, except to secure the benefit of foreign technological developments, had largely stopped after 1931, while domestic equipment production was undergoing considerable expansion, although falling short of plan. As Holland Hunter demonstrates, however, the share of railroad investment in total investment declined substantially under the First Five Year Plan by comparison with the late 1920's.[16] This

[12] See the report of the American Relief Administration quoted in *Railway Age,* Vol. 72, 1922, p. 92, and the account of Captain Geofrey L. Carden in *Railway Age,* Vol. 74, 1923, p. 72 ff.

[13] Sidney Brooks supplies an account of the beginnings of recuperation in *Railway Age,* Vol. 76, 1924, p. 129 ff.

[14] Mr. Ralph Budd, subsequently president of the Burlington System and dean of American railroad presidents, actively headed the study of Soviet requirements and the planning which lead to recommendations by his mission for rehabilitation and expansion. A strong German influence is also apparent, reinforced by a considerable import of motive power and other material manufactured in Germany.

[15] Drucker makes the point, important in considering the significance of the Soviet experience for underdeveloped countries, that the USSR inherited a good transportation system. Notwithstanding the inability to support the mass military operations of World War I, this is, of course, true. The problem of the 1920's was one of rehabilitation of a system of considerable size which had once been well equipped. See Peter F. Drucker, *Landmarks of Tomorrow,* New York, 1959, p. 169.

[16] Holland Hunter, *Soviet Transportation Policy,* Cambridge, Mass., 1957, pp. 54 and 71.

limitation of investment apparently affected all phases of rail plant and not merely motive power and rolling stock.

In the development of the First Five Year Plan, which was launched in the fall of 1928, it is clear that considerable attention was paid to the relation transportation development should bear to the industrialization program. The background is admirably treated elsewhere and need not be repeated here,[17] but we may be permitted a few comments upon strands of policy which, modified to cope with events, have persisted to the present day. As Hunter points out: "Received Soviet doctrine sees only that transportation diverts resources from producing output." The planning work and the published discussion—then more free than at later periods—of both the State Planning Commission and the Commissariat of Means of Communication are similar to those in the Western world during times of war pressure. The relation of transportation to industrialization as a whole set forth for the First Five Year Plan is characteristic of not only Soviet planning, though it has not been carried to similar extremes elsewhere, nor has it been extended to become parts of long-term policy elsewhere. Nowhere has it been adopted, either, when the basic plant was already weak for the job to be done or where such a large, continuing expansion of the needs of the economy was anticipated. In both the Soviet Union and the Western world the same arguments are advanced in wartime: rationalizing industrial locations and their supply, minimizing hauls in distribution, and intensifying the utilization of physical plant. The Soviet planners talk like the officials of a war production agency which is bent upon securing the utmost conservation of resources in such services as transportation in order that resources may be freed for other purposes which are viewed as more vital for immediate objectives. But the propositions, which in a Western country in wartime may be viewed as a temporary stretching of a basically adequate and somewhat elastic transportation capacity, become in the Soviet Union relatively permanent attitudes. In both cases they trade heavily upon theoretical technical possibilities but overlook the imperfections of the human tools and the motives that detract from maximum physical efficiency. Yet the Soviet administration was successful in one instance in clearing up a shortage of transport and restoring a modest traffic growth with limited help from increased physical plant in late 1933 and 1934. The restoration of a reasonable equilibrium with growth in the industrial sector, however, had to await increased investment in the railway's plant.

[17] *Ibid.*, Chapter 3.

During rapid industrialization the same conflict of demand for scarce resources becomes strategic as in war. A calculated risk is required, otherwise the heavy demands for steel and machinery for a similar percentage growth in the railroad system will tend to defeat the major objective of timing. This is particularly true in the case of the expansion of heavy industry, for the primary requirements of railroads are for the heavy structurals, castings, and forgings whose production capacity is limited and which are much in demand for the expansion of the manufacturing plant, including the steel industry itself.[18] A certain myopia pervades the planners in transport matters, theoretical efficiencies are treated as if they were actual, and the experienced transport operating officials are viewed as hopelessly conservative to the point of obstructivism. As a spur these attitudes are, no doubt, useful but when allowed full force in determining investment they may result in unexpected failures. The remarkable flexibility of a railroad system in the absence of interrailroad competition and commercial objectives and under strict discipline has been demonstrated in more than one country and on many occasions. But the Soviet planners may have cut too fine, although the reasons for the inadequate transport in 1930-34 also included the fact that the plan for output and delivery of major items of transport equipment was not fulfilled and that traffic demands increased more than anticipated. The average haul notably failed to respond to the prescribed treatment and increased with some promptness rather than falling. Nor is it clear that a wise distinction was made between the demands imposed upon motive power and rolling stock by an increase in tonnage originated as distinct from an increase in ton-mileage resulting from an increase in the average haul. An equivalent increase in ton-mileage from the latter cause is conducive to improved equipment utilization and makes proportionately less demand for railroad plant expansion, except for main-line capacity. Even if length of haul had been held within the planned limits, it is doubtful that the proposed expansion of rolling stock would have been adequate to cope with the expected tonnage originated.

The evidence from the Soviet statistics is not clear-cut, yet it bears some of the marks of congestion as the proximate cause of shortage of cars for loading. The growth of operating ton-kilometers slowed down before 1932. In 1933 ton-kilometers fell off slightly (see series C-6 in Appendix C). Carloadings likewise fell in 1933 after a very

[18] Care must be taken to work out requirements and availabilities in a shape and form breakdown if a correct appraisal of a railroad program is to be secured.

modest growth in the preceding year (see series C-4). Average carload appears to have held rather steady, except for a slight dip in 1932 (series C-5), and tons originated were virtually the same in 1933 as in the preceding year. Increase in the length of haul ceased in 1933. The backlog of unshipped freight was reported at 20 million tons at the end of 1932 and stood at the same level at the close of 1933. By the end of 1934 a reduction to 15 million tons had been effected.[19] It would appear that the car shortage, which was the immediate manifestation of inadequate transportation, was produced by a growing difficulty in the movement of cars through yards and terminals and on the line. Of course, it is possible that, had circulation been as free as in earlier years, car shortages would have developed from other causes, notably from the failure of investment in rolling stock to keep pace with the growth of traffic demand.

Available monthly data for 1933 show that the greater part of the difficulty was concentrated in the winter and early summer. An improvement occurred in the late spring, and the fall performance exceeded the comparable period of 1932, as can be seen from Table 7.

TABLE 7

AVERAGE DAILY CARLOADINGS, USSR, 1932-33, BY MONTH

	1932	1933
January	52,658	46,310
February	48,365	46,399
March	49,327	48,325
April	54,024	52,239
May	55,417	53,812
June	53,031	51,896
July	48,815	49,950
August	48,565	51,059
September	52,525	54,087
October	53,621	56,126
November	50,924	55,431
December	49,665	48,861

SOURCE: I. V. Kochetov, *Statistika zheleznodorozhnoi transporta* [Statistics of Railroad Transportation], Moscow, 1941, p. 61; *Socialist Construction in the USSR*, Moscow, 1936, p. 340.

Thus it would appear that severe winter conditions may have impeded operations in the early months of the year and contributed to a congestion which was difficult to clear up. There is some evidence to suggest that maintenance standards had deteriorated to the point of having an adverse effect upon operations. Thus there appears to

[19] See Hunter, *Soviet Transportation*, pp. 52-54, for a more extended account.

be an increase in accidents both on the line and in yards. Line-haul movement slowed down primarily from a drop in running speed between terminals, suggesting that poor standards of line and locomotive maintenance, as well as, perhaps, poorer quality of fuel, may have been contributing factors. This view is somewhat reinforced by the modest decline in gross trainload. Operating personnel declined in number somewhat and it is possible that an increase in crew overtime contributed to declining performance. Quite possibly the consequences of neglect beyond mere limitations of capital investments were being felt.

Certain other features of the 1933 performance are worth comment. Tariff ton-kilometers showed a small increase in 1933 and the excess of operating over tariff ton-kilometers grew from 4.25 per cent in 1933 to 5.67 per cent in 1934, perhaps an indication of increased line-haul congestion. Empty car-mileage evidently grew by nearly 10 per cent between these two years, a phenomenon contrary to that expected under heavy traffic pressure in competitive systems, but which can perhaps be explained by efforts to relocate cars and to give priority to certain traffic in car placement (see series C-33). Centralized distribution of empties by the Ministry of Transportation for so widespread a rail system need not be expected to work as the car service rules do on American railroads. Arbitrary car relocation here never affects more than a very minor portion of the supply. Both freight car and locomotive turnaround were more sluggish in 1933, thus depriving the plant of a capacity equivalent to its output in the previous year.[20] And this weakening of rail performance occurred in the face of some increase in the volume of traffic, a circumstance which is usually favorable to increased operating efficiency.[21]

By studying the growth of freight backlogs, Hunter attempts to appraise the inadequacy of rail transport during this critical period.[22] From the available data it does not appear that there was a major pile-up of unshipped freight, although substantial tonnages were awaiting transportation and the volume reached a peak in 1933. How-

[20] Both train speed and locomotive-kilometers per locomotive-day declined, indicating a slowing down of line-haul performance without, however, giving any direct clue to reasons. This plus the increased haul of empty cars was probably more influential in the lengthened freight car turnaround than deficiencies in the shipping ministries in loading and unloading cars. The composition of car turnaround does not show a growth in the time required for loading and unloading, but there is some doubt as to the reliability of these data.

[21] The year 1933 was, however, a poor one for heavy industry. The marked renewed rise in heavy industrial output occurred in the following year.

[22] Hunter, *Soviet Transportation*, pp. 59-60.

ever, this approach runs the risk of understatement. Many types of industry lack ample or expandable storage prior to transportation in the Soviet economy as in others. It would be interesting to know whether any stoppage of production or slowing down of production occurred in consequence and to appraise its significance. There is some evidence pointing in this direction, though a quantitative analysis is impossible from the data at hand. It is apparent, however, that the shortage of transport was taken extremely seriously at top government levels in the Soviet Union. It is also apparent that the measures taken were highly effective since they were applied to a rail system which for some time had been laboring close to the limits of its capacity.

The year 1934, if the statistics are to be believed, saw an increase in tons originated which had been equaled only once before—in the increase of 1930 over 1929—while the average haul resumed its increase. In consequence, operating ton-kilometers increased by 23 per cent, building upon the recovery of the late months of the preceding year. Sharp improvements in the operating indexes occurred and appear to bear the major responsibility for improved traffic performance at this stage of the crisis. In 1934 the Soviet railroads, according to the statistical record, tightened their operating performance, and it is clear that the shipping ministries, goaded by officials from Stalin on down, cooperated in a more effective fashion. Although unshipped backlogs remained at the end of 1934, the crisis was in good part broken before significant relief could be secured from increased materials allocations and their embodiment in additional line and yard capacity, motive power, and cars.[23] Thus average static carload increased 8.7 per cent in one year[24] and car turnaround time decreased by 8.5 per cent.[25] Locomotive-kilometers per active freight locomotive-day showed a modest increase and reached a new high. And average freight trainload increased significantly. Unhappily it is impossible—in the light of the statistical deceptions known to be inherent in the reporting system of the Soviet railroads, known changes in reporting concepts at various times, and the general looseness of statistical con-

[23] As noted below, there is evidence of some increase in equipment in 1934 which should have been of assistance to the operating authorities in the latter part of the year.

[24] Static carload represents the tonnage loaded in the average two-axle unit and is computed by dividing tons originated by carloadings (in two-axle units). It should not be confused with dynamic carload, which is computed by dividing net ton-kilometers by loaded car-kilometers. The use of tariff ton-kilometers for computing this will tend to show it in a poorer light than was actually true.

[25] That the official data somewhat overstate the improved turnaround can be argued from the data in Appendix A.

trol—to assess the degree to which performance actually improved in the year in question as a result of efforts to cope with the crisis.[26] It is probable that the improvement was less startling than that on record. Doubtless heavier maintenance expenditures beginning in 1933 must have contributed to these results, although it has not been possible to pin down the evidence. Expansion in the numbers of operating personnel is, however, apparent. These events may indicate that the system had margin for improvement despite its apparently hard-pressed condition in 1933, but the exact extent of improvement actually achieved remains unknown.

Nevertheless it is clear from Hunter's analysis that investment in the railroad sector had lagged and that an 18 per cent cut was imposed in 1933 at a moment when the shortage of transport and its potential effects should have been clearly apparent.[27] Though congestion appears to have been alleviated in large part by tightening performance, growth could only be resumed by rectifying the proportions of investment between transport and other industry. Without detailed analysis of the impact of an enlarged railroad program by shape and form breakdown and by component capacities, it is impossible to say whether increased allocations could have been made for the required rail items without imposing serious delay upon the heavy industry program. In 1934 and 1935 more favorable treatment was accorded the railways, but thereafter, as the crisis was regarded as solved, much emphasis was again placed upon tightening performance in order to cope with steadily growing traffic, and performance factors generally improved into 1937.

The year 1935 provides one of those interesting anomalies in the official Soviet account of events. Although performance had been improved in 1934, backlogs of unshipped freight had been reduced either by movement or by local absorption, and an expansion of plant and equipment through increased investment was already under way, delayed reaction to the "crisis" resulted in the discredit of the railway administration and the appointment of Lazar Kaganovich on February 28, 1935, as Minister of Transportation. The tenor of the official view of the magic worked by his administration is indicated in Appendix A.[28] Analysis of the available data for 1935, however, tentatively

[26] No definite evidence of statistical manipulation or changes in the basis of reporting appears during these critical years, although there are known changes in the basis of reporting certain data in other years. The concept of active locomotive fleet, which has changed, appears to have remained stable in these years.

[27] See Hunter, *Soviet Transportation*, p. 71.

[28] See also *ibid.*, pp. 74-80.

suggests a considerable deception in the Soviet figures, particularly in the calculated average car turnaround. For it appears probable that the increase of freight cars in the fleet under railroad jurisdiction was slightly understated in 1934 and considerably understated in 1935. The understatement of the increase in the active or working fleet may have been greater. Such an understatement of course makes the car turnaround appear to have improved much more than may actually have been the case. A series of calculations in Appendix A tentatively assigns 69 per cent of the increased carloadings of 1935 to the increase in the active freight car fleet and the remainder to an improvement in car turnaround.

It is notable that there was a significant increase in the production of new locomotives in 1934 and a still greater one in 1935. Furthermore, the FD type, which is the heaviest class of freight power in common use on the Soviet railways and which has approximately 10 per cent more tractive effort than class E, began to be produced in great quantity in 1934 and represented slightly over one-third of 1935 production. Apart from their increased drawbar power, these locomotives were also given larger driving wheels and more ample boilers, and hence were capable of higher speeds in road service. The acquirement of such a considerable number as 1,123 heavy freight locomotives in 1935 must have contributed to the faster clearance of yards and improved road speed. Their concentration on the heavy traffic lines, which may be presumed to have suffered the greatest congestion, must have had a more beneficial effect than can be traced through the system averages. The base was laid in 1935 for the improved performance of the two subsequent years, and it is noteworthy that locomotive building remained 50 per cent above the 1932 level right through 1938. Such evidence as we have suggests that improved traffic performance should be attributed more to improvement of plant and equipment than to any administrative legerdemain, despite the emphasis placed on the latter in the Soviet literature.

The year 1938, however, saw a slight fall in carloadings and in tons originated despite an increase in average carload. Revenue ton-kilometers continued to grow as a result of increasing average haul, but car turnaround was notably slower and to a degree which cannot be accounted for by the increase in average haul alone. On the average, shippers required two hours more for loading and unloading than in the previous year, which had represented an all-time record for effective car handling; but the increase of delay in classification

yards was more serious in its effects upon turnaround time.[29] Empty car-mileage again increased, but probably not for the same reasons as in 1933. Inasmuch as line-haul movement seems to have been well maintained, it is to the deterioration of work in classification yards, as well as to the slower working of cars by shippers, that we must look for an explanation of diminished loading capacity. No satisfactory explanation appears, but the data bear the earmarks of lagging demand for transportation. Railroads generally perform better under the pressure of a traffic demand in excess of capacity to haul, other things being equal, and utilization will necessarily fall if the pressure diminishes. The rate of growth of Soviet production, it appears, was showing a tendency to slow down, and there may have been less severe pressure on car turnaround.

The composition of traffic underwent interesting changes. While coal, coke, petroleum, firewood, and grain originations increased, the traffic in ores and in iron and steel and timber declined. Allowing for the shift of a large tonnage out of the other freight category into mineral building materials, it would appear that other freight suffered a minor decline. The nature of these shifts would not suggest a shortage of transportation capacity. Moreover, the monthly loading data make clear that the modest decline in originations was well spread through the spring and summer months. Somewhat of a recovery appears to have begun in the fall and may conceivably have been affected by relatively heavy grain movements.

Recovery in 1939 was marked, with a growth of approximately 8 per cent in tonnage originated and a smaller growth in ton-kilometers because of a slight reduction in length of haul. Car turnaround improved, but the more liberal supply of cars made it unnecessary to achieve the very rapid movement of 1936 and 1937. Shippers' handling of cars appeared to have established a new record and the movement of cars through classification yards was fully restored to its earlier level. Trainload, train speed, and average kilometers per active locomotive-day all increased somewhat. There appears to be an unexplained inconsistency in the Soviet data, however, for while train speed increased and the average turnaround trip of a freight car declined slightly, more time is reported to have been taken by the average car in motion between terminals.[30] Further improvement occurred in 1940, with approximately the same increase in tonnage originated. It would appear, therefore, that on the eve of the war the Soviet

[29] See *ibid.*, Table 76, p. 409.

[30] See series C-31 in Appendix C and compare with Hunter, *Soviet Transportation*, Table 76, p. 409.

railroads were in a strong position with adequate capacity for the demands made up to that time, with a remarkably liquid freight movement, and with well-developed techniques for handling mass freight transportation under difficult weather conditions as well as under favorable circumstances. The actual state of the railroads contrasted strongly with the low esteem in which they were generally held in the Western world.

Freight Traffic Performance in War

The Soviet railway system manifestly proved adequate to support massive and effective military operations. The means by which this success can be judged are meager, for information on the war period is largely lacking. As related to Soviet economic growth, the events of the war years in terms of actual traffic and operating performance are of limited significance. The losses sustained, the recovery therefrom, the influence of foreign assistance, and the test afforded of operating practices are not, however, without importance. In appraising them, it is particularly necessary to bear in mind that the conditions encountered in the Soviet Union differed very sharply from those in the United States and Great Britain, and even more sharply from those in the area of Greater Germany. For the Soviet system contracted and the wartime requirements developed on an industrial base which was already operating in nearly as high a gear as possible. Not only did the rail system contract with the loss of territory, but the industrial base was also reduced by the loss of the intensively developed Donbas, and the lines of communication to the armed forces were substantially shortened for a significant portion of their requirements. Hence the history of Russian wartime rail transport is altogether different from that of the German rail system during the same period.

Soviet prewar opinion, as reflected in a number of the writings which no doubt had been influenced by the "transportation crisis" and by the experience of the first war, tended to forecast serious transportation difficulties in the event of war. There was, however, considerable prewar strengthening of the rail net by new construction and its continuation during the war by the completion of lines of strategic importance, particularly in support of Leningrad and Stalingrad, and of lines necessary to the expanding trans-Ural industrial base and the opening up of alternative resources.[31] There was, moreover, the noteworthy wartime "compression" of operations, to use Hunter's

[31] Hunter, *Soviet Transportation*, Chapter 5.

term: the decline of operated first main track from 95,526 kilometers[32] in 1940 to 69,000 in 1942, the loss including the heavy-density network of the Donbas, and the quite successful withdrawal of motive power and rolling stock from the areas which came under German occupation. This, of course, considerably increased the density of power and car stock per kilometer of line for the remainder of the system and created a surplus where tightness had been the historical experience. The wartime traffic pattern, on the basis of the slim evidence available, shows a relatively small direct military component and a decline in total traffic considerably greater than the reduction of line operated. This apparent Soviet experience checks with our own in the two wars. It is, moreover, of large importance that the bulk of the lines lost were in the heavy-density areas which, in the Soviet economy, compare with our northeast, while the lines remaining in the operating system more nearly resemble our light-density western lines.[33] Hence system traffic density declined, although many important routes carried much heavier traffic than previously, and required work in the way of construction of auxiliary track to increase line capacity and the capacity of yards and terminals. This phenomenon had something of a parallel in the U.S. transcontinental routes because of the wartime growth of west coast industry and the supply demands of the Pacific theatre.

Of the factors explaining the comparatively satisfactory wartime performance of the Soviet rail system, the most important, of course, is the contraction of the system and of the area served with the resulting surplus of power and equipment. Yet it is important to note that the great rollback of the German armies and the invasion of Germany itself was adequately supported by a rail system which had to reconstruct before it could operate in the recovered territory. As Hunter emphasizes, however, the reconstruction was of lines required to service the advancing armies as supply routes. Reconstruction for economic purposes followed, as the rehabilitation of the occupied areas got under way and was spread over a considerable period of time.[34]

[32] Hunter's figure, which is the annual average. See series C-35 in Appendix C where the kilometrage for the expanded territory is given as 106,102 at the end of 1940.

[33] Garbutt estimates that the lines in occupied territory handled 40 per cent of prewar Soviet traffic (P. E. Garbutt, *The Russian Railways*, London, 1949, p. 22). It appears quite possible that this is an understatement of the facts.

[34] See Hunter, *Soviet Transportation*, pp. 102-104. The complaints of the Soviet military, notwithstanding an apparently outstanding performance of the rail authorities, are noted in Raymond L. Garthoff, *Soviet Military Doctrine*, Glencoe, Ill., 1953, note 40. Carloadings grew approximately 20 per cent in 1944, but only 11 per cent in 1945. It was not until 1949 that the prewar level of carloadings was reached and passed.

The statistical record of the war years is highly incomplete, hence less can be learned of railroad operations than for prewar and postwar years. The discussion which follows is offered not because the war years shed any particular light on Soviet economic growth over the long term, but rather because the ability to get through the war successfully speaks well for the Soviet railroads, while the vast problem of reconstruction which stood in the way of postwar recovery cannot be understood without devoting some attention to the contraction and destruction of the system.

The more intense working of the easterly lines of the Soviet system required an increase in their capacity, as noted above, through the construction of additional trackage and the improvement of signaling and operating procedures. For a time, motive power and cars should have presented no difficulty except for finding ample track storage for surplus equipment. As the system's manufacturing and heavy repair facilities had also been located on the lines which were now occupied, even the ability to provide new equipment was temporarily lost, and the surplus had to be traded on by increasing the bad-order ratio[35] and, in time, cannibalizing unserviceable equipment. Shops were, however, expanded on the eastern lines and the notable works at Krasnoyarsk apparently were established by the evacuation of older plants from the west.

Deliveries under U.S. Lend-Lease provide a clue to the problems faced by the Soviet lines both in maintaining themselves in the later stages of the war and in launching the westward extension of military supply lines. These deliveries included sizable quantities of rail, frogs and switches, block signal equipment (including the first centralized traffic control panels and circuits used in the Soviet Union), portable electric generating plants carried on railway cars, car wheels and axles, air brake sets and other car specialties, and some 1,800 standard steam locomotives (largely of the Decapod 2-10-0 type similar in capacity and general features to the locomotives built for Imperial Russia during the first war, but equipped with certain modern specialties and generally more satisfactory from a maintenance point of view), plus a few electric and diesel units.

Brief consideration will make clear the need for these items. A good part of Soviet capacity to roll rail had been lost. Considerable quantities of material were needed to be able to lay yard and side track, to carry out certain important line extensions, and to add second main running track at points of congestion. Block signaling equipment was

[35] The ratio of unserviceable cars to the total number of cars.

badly needed in order to increase the capacity of lines which had become congested by an unwonted flow of traffic. Centralized traffic control served the same purpose, but the amount exported could only provide a token installation on some selected segment of line. Certain steel imports of standard shapes and forms may have provided some underframe material for freight cars. Wood, a relatively abundant commodity in the USSR, is heavily used for flooring and sheathing many types of Soviet freight car. Indeed it may be said that the composite car is still standard Soviet practice although it has seldom been built in the United States since the middle 1920's.[36] Hence the principal steel items required for new cars and heavy rebuilds would have been underframes, wheels and axles, truck side frames[37] and bolsters, couplers, and other specialties. Of these, Lend-Lease provided considerable quantities. Both the assembly of new and the heavy repair of old cars can be carried out in the open at any suitable site and with a minimum of equipment. The supply of specialty components and of heavy steel shapes for the underframe is the principal limitation.

The locomotives supplied under Lend-Lease were undoubtedly important in maintaining an ample supply. They were basically similar to the light Decapods which had been extensively used in Russian heavy freight service for a number of years. Simple and rugged in design with relatively light moving parts, they were easy to maintain with a minimum of back shop equipment[38] and a labor force of small mechanical skill. Moreover, even under Soviet conditions, they should have been good for two or three years of service without heavy repair. The testimony of one U.S. Transportation Corps mission which had the opportunity to observe briefly rail operations behind the Soviet lines indicates that the working stock was in part maintained by ditching locomotives requiring heavy repair and replacing them with new imported power.[39] The unserviceable locomotives could then be

[36] During the second war composite gondolas and hoppers were built in the U.S. because of the shortage of steel plate. No box cars were permitted to be built at that time.

[37] Considerable use was still made of arch bar frames which could be fabricated from small steel shapes.

[38] The phrase "back shop" refers to heavy repair facilities generally connected with engine houses and widely distributed over the road.

[39] Motor trucks, which were provided under Lend-Lease in very large numbers, appear to have been used in the same way and played a significant part in military supply operations. It appears that in the late phases of the war, Soviet forces operated at times from 200 to 400 miles in advance of railhead. Living off the country, they depended at times upon trucks for ammunition and fuel. Nevertheless, major rail supply lines underwent remarkably rapid restoration and often paced the movements of the front, resulting in the arrival of supply trains at points still being fought over or under fire.

cannibalized to repair others. It is no doubt significant for an appraisal of the Soviet shop position that, whereas components of freight cars were imported, the demand in motive power was for complete assembled locomotives shipped with the main rods down but otherwise ready to run.

Soviet operating practices were well adapted to placing a heavy traffic load on available railroad lines. Their prewar passenger timetable showed a small volume of main-line intercity service. Even on relatively important lines, only a few daily trains were scheduled and the heaviest of such workings were in the territories now occupied by the enemy. Under the exigencies of war, it may also be presumed that little effort was made to hold to booked times when the pressure of freight traffic was severe. And as fast passenger service was virtually unknown, so also was fast freight service. Hence the sharp reduction of line capacity occasioned by having one or more fast preferred trains on the line was avoided. The slow pace of movement also permitted relatively close headway, and where electric staff proved inadequate for the press of traffic and block signaling was unavailable, a manual block could be improvised by hand signaling. Where line capacity governed, a relatively even dispatchment of trains could be arranged over the twenty-four hours. It is unwise to apply conclusions drawn from Western experience to such basically different conditions.

In the movement westward, involving extension of the lines supplying the armed forces, the contrast with Western methods was sharply apparent and in part explains our wartime inability to believe that the advancing Soviet armies were adequately supplied. It is first to be noted that the daily supply requirement of a Soviet division was substantially under the tonnage required by its Western counterpart and that irregularities of supply, particularly of food, were accepted.[40] But the most striking differences are in the methods by which a limited open rail network was turned to account. Again the U.S. Transportation Corps mission sheds some light. Where possible a single-track line would be paired with another lying cross-country, each line being operated in a single direction, giving the effect of a double track. Elsewhere on single tracks, groups of trains were sent in one direction during a portion of the day in order to eliminate meets.[41] Of the

[40] A most interesting, though brief, account of Soviet logistics is given in Garthoff, *Soviet Military Doctrine,* pp. 290-294. The whole system of supply appears to have been as haphazard as the rail movements up to railhead, and the notion of orderly stocks at specified levels and in particular relationship to the front appears to have been lacking.

[41] Both of these methods have been employed elsewhere, but on a more limited scale.

greatest importance, forward depots with extensive rail trackage, yards, and sidings were hardly required. For the Soviet technique was to supply enough labor, conscripted from the countryside if need be, to unload a full train simultaneously and at a fast rate. Hence it was unnecessary either to break up trains at railhead or to provide extensive trackage to hold cars, and the use of equipment was maximized.[42] It is clear that Soviet railroad men had both skill and a spirit of improvisation and their long training in high-pressure operations in peacetime undoubtedly stood them in good stead. Their skill in restoring destroyed or damaged trackage, bridges, etc., is discussed elsewhere.[43]

Reverting, however, to operations in the unoccupied areas, some confirmation of the general pattern of performance can be gleaned from the operating statistics. Carloadings and tonnage originated had reached peaks in 1940, influenced somewhat by territorial acquisitions.[44] Both declined in 1941, but a sharp contraction to the wartime low was marked in 1942 when carloadings stood at 43 per cent of the 1940 high. Tonnage originated fell less rapidly, for there was a marked increase in the average load per two-axle unit from 16.6 tons in 1940 to 18.6 tons in 1942, and this increase continued the following year.[45] The contraction of operations to the east where the population was less dense and distances greater was reflected in an increase in average haul, although this was less noteworthy than might have been expected, from 700 kilometers in 1940 to 786 in 1942.[46] Hence the fall in ton-kilometers was considerably less than that in carloadings. The abundance of freight car equipment is confirmed by the decline

[42] Of all measures rare in Western practice, this was undoubtedly the one of most importance.

[43] See Hunter, *Soviet Transportation,* Chapter 5. Garbutt (*Russian Railways,* p. 24) cites Soviet claims that the bridge over the Dnieper at Kiev, 1,100 meters long, was replaced with a temporary structure in thirteen days and that a larger structure was completed at Dnepropetrovsk in twenty-two days. Single-track working was required for some time over the greater part of the restored system and the replacement of temporary structures was spread over a considerable period of time. On the other hand, a Soviet military complaint is recorded to the effect that restoration progressed at a tempo hardly faster than during the first war, although track restoration up to twenty kilometers per day and more is recorded (see Garthoff, *Soviet Military Doctrine,* p. 292). The Soviet press, notably *Zheleznodorozhnyi transport* [Railroad Transportation] (issues of 1944 and 1945), contains detailed accounts of very creditable performance in the face of heavy destruction by the retreating enemy. Very heavy forces were evidently employed to secure the simultaneous reconstruction of a large aggregate mileage.

[44] It should be observed that the eastern Polish lines acquired by the Soviet Union represented the light-density portion of the Polish system.

[45] See series C-2, C-4, and C-5 in Appendix C.

[46] Further increases are estimated to have occurred in the following year, but a decline appears to have been encountered in 1944 (see series C-3).

in car-kilometers per active freight car-day from 139.9 in 1940 to 94.6 in 1942, while the average turnaround time grew from 7.37 days to 13.8 days. The proposition that the trans-Ural industrial complex required excessive empty car movements to balance equipment in the face of unbalanced commodity flows is perhaps confirmed by the rapid growth of empty car-kilometrage per freight car turnaround from 300 kilometers in 1940 to 385 in 1942 and 439 in 1943, although other interpretations can be supplied to account in part for this phenomenon.[47] These operating statistics should not be viewed as the result of a deterioration, much less of a breakdown, in Soviet rail performance. They are the natural result of a surplus of equipment, congestion of lines and terminals, and the slackening of effort in loading and unloading which an abundance of cars makes possible. It would appear that an expeditious adjustment had been made to sharply changed conditions, aided in due course by the importation of supplies from the West through the three primary gateways in the rail system.

During the movement westward in 1943-45 the growth of operated line was rapid, although much of the restoration was temporary and did not include normal facilities for commercial traffic. Freight traffic grew less rapidly than operated line, as is apparent from the percentage relationships in Table 8.

TABLE 8

SOVIET FREIGHT TRAFFIC, 1942-45
(per cent of 1942)

	Kilometers of Line	Average Daily Carloadings	Tons Originated	Tariff Ton-Kilometers
1943	129	107	109	113
1944	176	130a	128a, b	131b
1945	179	145a	137a	138

SOURCE: Series C-34, C-4, C-2, and C-1 in Appendix C.

a Average carload declined after 1943 and approximated the 1941 level in 1945.
b Average haul declined in 1945 and appears to have declined in 1944. In the earlier year it still stood some 13 per cent above the prewar level.

It is well again to caution the reader that the material upon which estimated operating and traffic data for the war years are based is highly fragmentary. Nonetheless it is reasonably apparent that the rapid restoration of first main track in liberated territory was not matched by increase in traffic, particularly because the economy of

[47] See series C-33.

these areas was prostrate and large-scale economic reconstruction could not get under way during the massive drive to the west.

Postwar Developments

Little expansion appears to have occurred in the postwar period, for the 1953 network exceeded that of 1945 only by 7,000 kilometers (see series C-35). Postwar reconstruction was devoted to restoring the capacity of the reacquired network and subsequent efforts have been in intensive development, such as improved signaling, lengthened sidings, enlarged yards, the partial mechanization of yards, and additional multiple tracking at certain bottleneck points. Indeed the intensive development of the system since 1949 has been startling in its effect. Whereas freight traffic density (ton-kilometers per kilometer of road operated) more than doubled between 1933 and 1939, it now increased by another 60 per cent in a brief six-year period (see series C-36). The data in Table 9 show in summary form the return to prewar traffic density and the subsequent expansion. A railroad system

TABLE 9

SOVIET FREIGHT TRAFFIC DENSITY, 1939, 1945-54
(thousand ton-kilometers per kilometer of line)

Prewar		Reconstruction		Postwar[a]	
1939	4,570	1945	2,809	1950	5,170
		1946	2,952	1951	5,774
		1947	3,053	1952	6,272
		1948	3,855	1953	6,689
Prewar attained		1949	4,519	1954	7,134

SOURCE: Series C-36 in Appendix C.

a The period bears some resemblance to the intensive development of the U.S. system during 1904-14, a matter which will be discussed further. But such comparisons should be approached with great caution.

faced with this type of situation must pursue a course of development quite different from the one it would follow if it were growing largely out of the conquest of new territory and the channeling of increased density in the older areas over a few highly developed trunk lines.

Following 1946, operating ton-kilometers grew at an annual pace of 80 billion until 1952 when the increase was about 60 billion, a figure which was approximated in each of the following two years. Not only has growth not ceased, but the increase in operating ton-kilometers was somewhat greater in 1954 than in the preceding year, and in 1955 the annual increase moved above 100 billion. As these are estimated

by extrapolation of the divergence from tariff ton-kilometers which is believed to be diminishing during recent years, the increase in tariff ton-kilometers has been somewhat less, although it has followed the same general pattern. Average length of haul reached a low of 712 kilometers in 1949, compared with 700 on the eve of war, and has since gradually increased, as far as it is possible to estimate from available data, reaching 757 kilometers in 1954 and 815 in 1957. The latter level has been approximately maintained. In consequence, the growth of tonnage originated has been slightly slower than that of ton-kilometrage. Average carload (per two-axle unit), which declined from the wartime level during the earlier restoration period, has since been increasing and reached 19.8 tons in 1954;[48] by 1960 it reached 21.5 tons. Hence growing traffic has not required an equivalent increase in carloadings for its accommodation.[49] Moreover, car turnaround has improved every year since 1942 with the exception of 1954 and 1956; by 1953 it surpassed the best record of the late 1930's, and since then has been superior to any prewar performance. The 1959 datum represented a new record of 5.72 days.

While way and structures have undergone intensive development, motive power and rolling stock have necessarily been increased in numbers and the principal investments in railroads have gone into these items. Although we have no direct data on the numbers of locomotives or of cars owned or in service since 1940, the active fleets can be calculated directly from the operating statistics. The active freight car fleet reached a low of 576,000 two-axle units in 1943. The 1940 level of 721,200 units was exceeded in 1947 and since that time growth has averaged 40,000 two-axle units per annum (see series C-26). The aggregate carrying capacity of the active fleet would appear today to be approximately double that of 1940 whereas the operating ton-kilometers have multiplied by two and a third. Not only has the earlier level of efficiency in car handling been regained—it has been substantially surpassed, and the required investment in rolling stock

[48] It is of more than passing interest that average carload had increased 18.5 per cent since 1940, whereas the average capacity had increased but 15 per cent. Another difference thus appears between the Soviet position and that of Western countries where commercial practices tend to limit the advantage obtained from increased unit capacity. The static load of 19.8 tons compares exceptionally favorably with the average capacity of 24.1 tons in 1954. All of these data are in two-axle units.

[49] The qualification noted in discussing Soviet weight of lading practices should be recalled. It is always possible that apparent trends in average load are the result not of heavier actual loading but of an increase in the overstatement of loading.

accordingly limited.[50] Yet we have no substantial evidence that the pressure is excessive or that any significant shortage of rail capacity has developed, although there have been warnings that such shortages might again occur. If the exceptionally intensive utilization of all elements of the rail plant in the late 1930's requires explanation, then that of the period since 1950 is even more in need of explanation. In part this will be accomplished through a subsequent study of the operating statistics. But in part the explanation is to be found in conditions extraneous to railroad operation and in policies established for the governance of shippers and carriers alike. Attention will be focused in Chapter 3 upon factors which affect the traffic—its volume, composition, flow, and periodicity as a prelude to the discussion of the operating statistics in Chapter 4. For the traffic conditions which Soviet railroads face are fundamentally different from those which prevail in Western countries.

Railroad Passenger Traffic

Passenger operations have an effect upon the freight capacity of a rail system and it is for this reason that a brief examination of these operations seems useful. Not only has the automobile remained unavailable on any considerable scale, but very little intercity motor bus service has been developed, except as a very minor feeder to the rail lines and as a token service between a few of the larger cities in the west. While progress has been made in commercial aviation, the airplane has not become a mass carrier of passengers but serves largely priority purposes on a limited scale and is of major significance only on the long routes. Hence the railroad remains the principal means of passenger transport save where steamer lines are available on certain of the larger watercourses and in coastal waters.[51]

Because of this primary reliance upon railroads, Soviet rail passenger traffic is large and its density over the thin route network of the Soviet rail system is heavy. In comparison with the size of the country and its population, however, even this large traffic suggests a relatively immobile people.[52] Moreover, as will become apparent, by far the

[50] The possibility of increasing deception in the data along the lines discussed earlier must always be borne in mind, but it appears to us improbable that the position relative to earlier years is materially overstated.

[51] A sixfold expansion of air passenger mileage by 1965 is planned which would bring air passenger volume to some 20 billion passenger-miles and extend substantial relief to rail long-haul passenger services.

[52] If the large use of the private automobile in the United States, which for many years has accounted for more than 85 per cent of the intercity passenger movement,

larger part of Soviet rail travel is short-haul commutation service around the large metropolitan areas where the railroads serve more nearly in the fashion of the British and Continental railroads than like those in the United States, i.e., much that is done by automobile or bus in this country is a steam railroad job in the Soviet Union and in other countries.

Soviet passenger traffic stood at a low level in 1921/22, less than half the prewar volume. Not until 1929 were the 1913 passenger-kilometers surpassed. The restoration of freight traffic came first and comparatively little was provided in the way of passenger train accommodations, although trains were restored to punctuality, efforts were made to clean up the equipment, and certain dining car services were resumed, the latter largely for the effect upon morale. After 1923/24, the average length of passenger trip remained quite steady. Between 1923/24 and 1929 long-distance passenger traffic grew slightly more than suburban traffic, although the latter stood in 1929 at approximately two and a third times the volume of 1923/24 (see series C-12 and C-15).

The early 1930's saw a remarkable growth in passenger travel. Between 1929 and 1932 long-distance traffic more than doubled, while suburban traffic came close to quadrupling. The relationship of this growth to urbanization will be apparent. Soviet passenger traffic in 1930 surpassed that of Class I railroads of the United States for the first time, and by 1931 it had exceeded the all-time high of American rail passenger traffic, which had been attained in 1923. The U.S. roads, under the influence of the automobile and the bus, had had steadily declining passenger traffic since that year and the rate of decline increased after the fall of 1929. It is of interest to note that Soviet commutation traffic in 1930 was approximately equal to that in the United States, but thereafter shot up rapidly while the U.S. traffic declined.

The years 1933-36 were marked by a lower level of passenger traffic, and the 1932 level was not attained again until 1937. The decline was almost entirely in long-distance traffic, for commutation traffic held quite steady during these years and showed some growth in 1936.

---

is ignored, we must reckon some 117 billion annual passenger-kilometers in recent years by the three principal modes of intercity commercial passenger transport, whereas the Soviet rail traffic is believed to have approximated 107 billion passenger-kilometers in 1952, for a population one-fifth larger than the American one. By 1959 the Soviet passenger-kilometers had grown to 164.4 billion by rail and approximately 170 billion by all forms of transport. Per capita use of mass transport would thus appear to have run above current figures for the U.S.

This performance is probably related to the development of the transportation crisis of the 1930's, for the priority necessary for freight service and the general shortage of line capacity no doubt prevented an increase in passenger service, which under other circumstances might have been undertaken. Indeed it appears that long-distance passenger services were curtailed in the interest of relieving freight congestion.

Soviet passenger service has, however, never been the embarrassment to freight service that is characteristic of competitive service elsewhere. As the timetables reveal, the service is infrequent, the majority of trains are local or accommodation trains, and booked speeds are low.[53] While rail passenger service is a necessity, there is no competitive stimulus to produce a multiplicity of lightly loaded fast trains nor is there occasion for the duplication of train service. The passenger service appears to be arranged more for the operating convenience of the railroad than for the convenience of the passenger. Few trains approach 30 m.p.h. in their speed, and only between Moscow and Leningrad is something approaching an express passenger service operated.[54] Over most lines a very limited number of heavy slow trains operate, affording minimum interference to the freight traffic which is accorded primary importance.

Between 1936 and the beginning of the war, the growth of passenger traffic was resumed, but at a moderate rate. From 90.9 billion passenger-kilometers in 1937, a prewar peak of 98.0 billion was achieved in 1940, but much of the increase must be attributed to enlargement of the rail system by territorial acquisition. Approximately half the total growth in these years was accounted for by the expansion of suburban traffic. Soviet long-distance traffic within the old territorial limits can hardly have grown significantly. At the end of the period, however, commutation traffic stood at 2.4 times the maximum volume ever attained in the United States. The average trip in commutation service has remained remarkably steady and is approximately the same as the U.S. figure. It would appear that an excellent job is done in handling intensive commuter loads although the standards of comfort and crowding leave much to be desired.

[53] The latest timetables to reach the United States are for 1959. See *Ukazatel' zheleznodorozhnykh passazhirskikh soobshchenii leto 1959 goda* [Railroad Passenger Timetables for the Summer of 1959], Moscow, 1959.

[54] Hunter, *Soviet Transportation*, Chapter 10, affords some comparison of various routes and years which are representative of the better long-distance services. It is recently reported that the Moscow-Leningrad service has been accelerated to six hours and twenty minutes, requiring an average speed of 63.7 m.p.h. (*Trains*, June 1961, p. 30).

The war years in passenger traffic, as in much else, are a blank. The 1945 volume, however, stood at approximately two-thirds that of 1940, the decline having been about the same in the suburban and long-distance services. The volume in 1946 approached the 1940 volume, apparently as the result of nonrecurring mass movements which affected primarily the long-distance services, although a bit of a bulge is also observable in the commuter traffic and the latter did not attain the prewar level until 1951. Schedule timings were, however, much slower than in prewar years and, although improved, remained inferior as late as 1949. A slight decline in total passenger travel for 1947 was followed by a precipitate decline in 1948. A return to the prewar level was achieved in 1951 and a steady, but moderate, increase occurred during subsequent years. The Soviet railways are, no doubt, now the largest passenger-carrying system in the world, having surpassed the British, while the German system has been cut in two parts. In number of passengers carried, the Soviet system still falls below the prewar German system, but its average haul in the long-distance services far exceeds the German performance. At present there is much to indicate progress in improving the quality of passenger service—transition to the all-steel car, improvement of appointments in the coaching stock and acceleration of certain services.

The selected data in Table 10 illustrate the position in recent years.

TABLE 10

SOVIET PASSENGER TRAFFIC, 1949-57

	Thousand Passengers		*Million Passenger-Kilometers*	
	Long-Distance	Suburban	Long-Distance	Suburban
1949	202,500	877,600	61,400	19,900
1951	214,300	1,101,000	73,400	25,100
1953	229,300	1,275,000	89,400	28,900
1955	249,400	1,392,000	109,100	32,300
1957	248,000	1,506,000	118,700	34,700

SOURCE: Series C-12, C-13, C-15, and C-16.

It will be noted that the number of long-distance passengers had declined from the 340.4 million reached in 1940. Nor had the level returned to that of 1945 as late as 1959. Nevertheless, passenger-kilometers in the long-distance service increased and by 1951 exceeded the prewar level. The average trip of long-distance passengers grew from 303 to 479 kilometers in the period covered by the table and thus stands some 120 per cent above the prewar datum. The restrained growth of long-distance trips in recent years is no doubt traceable in

part to the gradual shift of official and business travel to the airline services, although nothing approaching in volume the comparable shift in the United States has yet occurred.

No factor is of greater importance in permitting the development of a very large passenger business with a limited train mileage than the lack of standards of public service and the absence of any competitive pressure, which permit a load factor far in excess of anything achieved in Western countries and avoid the necessity of operating train services that the available volume of traffic will not justify. For in the Soviet system traffic is allowed to press upon the service and, whereas in the United States passenger load factors[55] are not much above 25 per cent for the service as a whole, the Soviet factors must be supposed to lie in the 80's if not higher for the long-distance services. On an equivalent load factor the train service operated in the United States might be expected to handle three times the present passenger-mileage and roughly this expansion occurred during the latter part of the war. To the load factor may be added the tendency to move the bulk of the traffic in cars equipped with wooden benches and arranged for high-seating density, the infrequency of the train service, and the heavy trainloads. If the Soviet freight service is reminiscent of American conditions in the first quarter of the present century, the passenger service recalls that of Western European countries during the same period minus the fast express services.[56] Few operating data are, however, available and further analysis would be relatively unproductive.

[55] Passenger-miles as a percentage of seat-miles operated.

[56] Load factors may, indeed, be higher than suggested above. Moreover, it seems probable that, at least in the first postwar decade, the volume of passenger traffic was restrained by the limitation of service. Edward Crankshaw notes that, "For years it was impossible, without the necessary *blat*, to get a railway ticket from Kiev to Kharkov," and he defines *blat* as a "peculiarly Russian mixture of spivvery and graft" (*Khrushchev's Russia*, Baltimore, 1959, p. 73). The recent U.S. railway mission to Russia reports that "they permit passengers to ride on top of trains, even in electrified territory with catenary, and through tunnels" (*Railway Age*, August 1960, p. 14). The same group reports that people wait in stations for perhaps two days at a time during peak travel seasons trying to board a train (*Traffic World*, August 6, 1960).

CHAPTER 3

Factors Affecting Soviet Railroad Traffic

Control of Freight Traffic

Railroads occupy an altogether different position in Soviet economic life from that in Western countries. Railroad transportation is something to be conserved and minimized under Soviet doctrine. Indeed, transportation is regarded by the Soviet party and planning authorities as something of a necessary evil and the traffic that necessitates its existence is to be bent in such a way as to minimize its demand for service and adjusted to the least physical outlay feasible. The Western view of fostering traffic development through service and rate improvement, adjustment, and experimentation has no counterpart, nor is there any competition for traffic among railroads or between railroads and other carriers, which in Western countries results in active rate warfare, competitive solicitation, and service concessions to particular traffic in order to secure or retain it.[1] The Soviet shipper faces a single railroad administration and the position of the latter is strong.[2]

Thus, according to Soviet theory, freight traffic is not a phenomenon that the railroad administration, its superintendents, or its agents should accept as beyond their control. Indeed, they are expected to take an active part in planning efficient transport movement, in detecting and stamping out irregularities which undermine railroad efficiency, and in using the means at their disposal to influence shippers and receivers of freight in ways considered desirable. To be sure there are continual complaints of shortfall on the part of the transport authorities at all levels—criticism particularly of the passive attitude that carriers should accept whatever is offered for transportation

[1] Over certain routes, of course, both rail and water services are available and on very short hauls motor transport now offers an alternative. The general rate level, particularly on bulk commodities, often results in a combination of lower rates as well as superior service where railroads are used in place of water carriers. But these rail rate levels are the result of general policy, not of specific competitive adjustments, and are, in particular cases, modified by arbitrary increases when directly competitive with water or joint rail-water routes in an effort to shed traffic from the rails.

[2] American shippers chafed under a benevolent U.S. Railroad Administration during and immediately after the first war. They would find the dependent position of the Soviet shipper impossible to comprehend. As the recent American railroad mission puts it, "They [the railroads] have a peculiar relationship to their 'shippers.' In Russia the opportunity to ship is a privilege." (*Railway Age*, August 1960, pp. 9-14.)

between all points. Thus, the Western theory of common carrier obligation is definitely out of place in Soviet thinking, yet it seems to linger on in the actions of the railway servants.

Numerous factors not ordinarily present elsewhere affect the growth and pattern of Soviet rail traffic. Some arise out of the general institutional and economic context in which the Soviet railways operate. Of great importance is the full six-day workweek and various labor practices designed to secure the fuller utilization of the industrial plant,[3] together with the established principle that transportation equipment should be loaded and unloaded seven days a week. Moreover, the emphasis placed on conservation of the railroad plant leads in many instances to the staffing of shipping and receiving departments around the clock. This has been facilitated in the Soviet Union by an abundance of common labor and an absence of overtime or of penalty pay for night and Sunday work. Labor awaits the cars rather than the reverse, and loading and unloading norms expressed in hours can practicably be substituted for the demurrage tariff and its forty-eight hours free time which is common elsewhere.[4] The great significance of the longer workweek for rail efficiency is made manifest by the postwar conversion of American industry to the forty-hour week. For this development has been calculated by the Association of American Railroads to have cost as much as 15 per cent of the capacity of our freight car fleet, even though it had not been our custom generally to work more than half a day on Saturday.

While the techniques of Soviet plant managers in their efforts to fulfill the plan and to avoid censure often appear to produce irregularities in the rate of production throughout a month, these much-criticized irregularities are probably smaller at the shipping docks and, in any event, are hardly as severe as the weekly and monthly variations in rail traffic in a Western economy. Moreover, the evenness of the Soviet flow is less often and much less severely affected by holidays. This should result in a more even traffic, both in origination and delivery, as well as a steadier car handling by shippers and receivers, with a highly beneficial effect upon car turnaround. If a yearly average turnaround of fifteen days can be achieved in the United

[3] A virtually universal full six-day week has not existed in the U.S. during the time covered by our rail statistics.

[4] A probably characteristic overemphasis is reflected in the following: ". . . many factory managers keep warehouse crews working three shifts, seven days a week. Factories retain an 'enormous number of reserve loaders' who could otherwise be used on assembly lines, a top Soviet economist says." (Edmund K. Faltermayer in *The Wall Street Journal*, July 26, 1960, p. 1.)

States at a high level of business with the present workweek and with our customary periodicity, something approximating an eleven-day turnaround would be expected in the Soviet system if only these differences in the regularity of flow were taken into account and no allowance were made for the immediate attention given to car loading and unloading with maximum useful forces. The latter easily subtracts an additional two days.

It is, however, also to be noted that the Soviet seasonal pattern in rail traffic differed from our own pattern during the period for which monthly data are available in a manner favorable to the Soviet system. Indeed little appeared that could be described as a seasonal pattern, other than a weakness in the winter months. In part, this is the result of the absence of certain commercial practices which affect seasonal patterns elsewhere; in part, it is influenced by the seasonality of the inland water commerce; in part, it results from the stronger influence of the upward trend of rail traffic; but whatever its causes, it is conducive to more effective year-round utilization of the rail plant. No recent data are available on the seasonal pattern of Soviet traffic, but carloadings by months have been published through 1938 and it is assumed that little unfavorable change has occurred. Data for the years 1934 to 1938 are shown in Table 11. The pattern is obviously affected by trend and in some years the growth trend is of sufficient prominence to expunge the seasonal pattern, as in 1935 when the year's increase over 1934 was substantial. The whole period covered by these data is one of rising traffic, with the exception of 1938 when there was a

TABLE 11

AVERAGE DAILY CARLOADINGS OF SOVIET RAILWAYS, 1934-38, BY MONTH

	1934	1935	1936	1937	1938
January	51,800	50,661	77,603	79,340	75,241
February	53,091	56,101	76,355	78,135	79,784
March	52,000	59,163	86,692	81,194	80,000
April	55,353	61,977	88,956	89,681	85,339
May	57,217	69,251	92,442	95,945	92,626
June	57,816	72,665	89,944	97,976	96,709
July	56,669	72,952	90,415	98,711	96,322
August	57,169	73,626	90,216	97,617	94,766
September	56,553	74,664	90,008	96,867	94,621
October	58,492	75,159	86,526	94,108	93,924
November	57,970	75,651	83,997	89,734	90,918
December	54,373	74,550	80,391	78,041	75,992
Full Year	55,717	68,098	86,660	89,833	88,046

SOURCE: I. V. Kochetov, *Statistika zheleznodorozhnoi transporta* [Statistics of Railroad Transportation], Moscow, 1941, p. 61.

minuscule decline in loadings. That year gives the appearance of a break in trend toward midyear representing a change from a rising movement of traffic to a decline. Nothing resembling a fall peak is apparent; the tendency for heavy agricultural loadings to produce heavier September and October loadings was offset by a general decline. The relationships between the high and low months of each year are shown below, together with the change between annual averages:

	Per Cent of High over Low Month	*Annual Average Increase (per cent)*
1934	13	9
1935	44	22
1936	21	26
1937	26	4
1938	28	−2

That the Soviet roads are affected by seasonal conditions in agriculture and by the closing of river navigation in the winter season surely is apparent, but the conditions presented do not appear to require the maintenance of substantial surpluses of equipment during a good part of the year for brief service in a fall peak, a situation which must have a considerable favorable effect on the operating averages. The strong upward pattern of traffic during the last decade suggests that trend may have been of more importance than seasonal during this period also.

Although the U.S. railroads were favored by a marked flattening of the seasonal pattern during World War II, a substantial seasonal pattern has been evident throughout most of their history. During the fairly steady year-to-year levels of rail traffic of the 1920's, it was customary for October loadings to exceed those of the low month by from 30 to 40 per cent.[5] During years of cyclical trend, declines have been marked by a moderation of the fall peak which has sometimes brought it below the spring peak, while recovery has been marked by rapidly developed and exceptionally sharp peaks. There is no year since World War II that could be considered "normal" in the light of postwar adjustment, recession and recovery, steel and coal strikes, and Korea. Nevertheless it remains true that in any year when a recession is not in progress the fall peak poses difficulties for the rail carriers and has, in every year except 1949, 1954, and 1957-59,

[5] For a graphic illustration of the variation of ton-miles, which are closely related to loadings, see Arthur F. Burns and Wesley C. Mitchell, *Measuring Business Cycles*, New York, NBER, 1946, p. 45. The loadings can be secured from and are graphically shown in the weekly carloading reports of the Car Service Division, Association of American Railroads.

been accompanied by moderate to severe car shortages. An interesting analysis of the effect of the seasonal pattern on requirements of the carriers for car ownership is given by Loree for 1906 to 1919: he charts the car idleness and computes the surplus of cars which would have resulted had the 1919 car mileage been secured in each year as well as the 1916 percentage of average carload to average car capacity. He thus develops surpluses ranging from 80,478 cars in 1917 to 853,343 in 1915 with a car ownership in the vicinity of 2,300,000 cars.[6] This does not suppose a complete suppression of the peak, but only the flattening characteristic of war periods.

As will appear below,[7] the absence of a marked seasonal pattern in Soviet freight traffic is not necessarily the result in all years of an absence of seasonal in traffic demands, but reflects rather an absence of accommodation of the plant to peak requirements, with the result that accumulations of unshipped freight may develop in spring and fall periods. These have been studied only for the critical first half of the 1930's, but it may reasonably be supposed that some seasonal accumulations are accepted as necessary for transport efficiency, with the result that the railroads work under year-round traffic pressures more nearly comparable to those of our annual averages. An argument can be made for comparison of Soviet operating data with our October rather than our yearly data. It may be that the pressures for quick realization of agricultural market values receive scant recognition and that certain categories of seasonal consumer goods are absent. In any event, the position of railroads in relation to shippers' desires differs markedly from that in our highly competitive situation. Whereas our calculations of car requirements inevitably start with an estimate of October peak traffic and October operating factors, Soviet analysts are more likely to resort to the use of annual averages and give scant recognition to seasonal demands.

Just as it is apparently considered unnecessary to provide a plant and equipment adequate to care for peaks of traffic with normal dispatch, so also several other features characteristic of competitive systems are absent. The limited and slow passenger service has already been referred to. The virtual absence of commercial privileges—holding for reconsigning, billing to order, tender in advance of shipping instructions, stopping to partially load and unload—which have been estimated to cost more than a day in the turnaround of the

[6] L. F. Loree, *Railroad Freight Transportation,* New York, 1922, pp. 277-279.

[7] See Appendix A.

average U.S. car, must contribute to high car utilization.[8] Moreover, the relative absence of ocean-borne import and export traffic, the absence of a water traffic even remotely comparable to our Great Lakes system, and the practice in any event of limiting car detention at points of rail-water interchange avoid the substantial accumulations of cars under load which customarily lie behind our ocean and lake ports. It is not uncommon for from 3 to 5 per cent of our car supply to be absorbed in such port accumulations.

Use of Rates in Control of Traffic

It is uncertain what relative weight should be placed on rates and other factors that affect the movement of Soviet traffic, but Soviet administrators obviously place considerable reliance on them. The proposition familiar to Western jurisprudence that transport rates should reflect transportation conditions and maintain a cold neutrality toward economic objectives, regional aspirations, or changes in political goals, though it is sometimes honored in the breach, has no parallel in Russia. Neither under the tzars nor under the Soviet regime has there been any reluctance to use transport rates to influence economic behavior and to assist political, military, and economic policies. Neither agreements among shippers and carriers nor longstanding rate relationships existing without complaint stand in the way of adjustments that are believed to provide incentives to desired behavior or erect barriers to undesired behavior on the part of shippers. But whereas rate-making practices under the tzars tended to support the pecuniary interests of particular favored economic groups, these practices in the Soviet regime have been devoted largely to stimulating the economy of use of transport facilities. Under both systems virtually universal use has been made of distance scales of rates with varying taper[9] and adjusted to particular rates per ton-mile at varying lengths of haul. And this type of rate is employed for water as well as for rail transport

[8] See Loree, *Railroad Transportation*, p. 266. See also *Freight Traffic Report*, Federal Coordinator of Transportation, Appendix I, Exhibit 222 (December 13, 1933, carload transactions), where substantial variations in intermediate terminal time for various commodity groups can be attributed to this factor. It is not to be expected that the up to thirteen diversions which have occurred in the U.S. grain and perishable trades would be permitted in the Soviet system, nor that commodities would be held under load awaiting sale for periods sometimes exceeding thirty days. Certain of these practices can be pursued by the Soviet shipper at the cost of monetary penalties and at the risk of administrative suppression. It is characteristic of most such practices in the United States that they are effected at a small charge, but carry with them from twenty-four to forty-eight hours free time under the demurrage tariff.

[9] Taper is a declining rate per ton-mile with an increase in the length of haul.

and with no apparent effort to equalize the two on point-to-point hauls or to establish differentials related to quality of service, but rather with a direct application of distances via the rate-making routes regardless of the relative circuity of water routes.[10]

The Russian State Council in 1887 assumed comprehensive control of railroad rates and promptly undertook a revision of the grain rates, spurred by the fact that grain was one of the most important commodities in rail traffic and by far the largest item of export. The Council introduced a uniform distance scale for application throughout the Empire and applied a marked taper. The existence of established grain production in Central Russia shortly led, however, to modifications to provide very low short-distance rates for the benefit of the landowners of that region while long-haul rates were subjected to increases. When in 1896 the western portion of the Trans-Siberian Railway was opened, the principle of inverse taper was introduced for the purpose of protecting the established areas. Thus while the portion of the haul lying between 895 and 1,094 miles took a rate of 0.250 cents per ton-mile, the charge rose to 0.391 cents for distances between 1,095 and 1,888 miles, and for greater distances to 0.564 cents.[11] While these rates appear to have discouraged the development of grain growing in the newly opened areas, they were far less severe in their treatment of the long hauls than are present Soviet tariffs.

The characteristic form of Soviet rates as well as the remarkable simplicity of the rate system are illustrated by the rates approved by the USSR Council of Ministers in November 1948.[12] Since they apply to twelve major commodity groups including coal and coke, ores of all kinds, iron and steel, lumber, building materials, fertilizers, sugar beets, and potatoes, these rates cover a great part of the total rail traffic.[13] There is only a limited spread among commodity groups,

[10] An odd result is that rates for an inferior water service frequently exceed rail rates between the same points and provide an additional cause for frustration in the effort to increase the use of the improved waterways.

[11] See H. R. Meyer, *Government Regulation of Railway Rates,* New York, 1905, Chapter VII.

[12] As yet there has been very little study of Soviet rail rates by Western scholars. Some material is contained in Holland Hunter's *Soviet Transportation Policy,* Cambridge, Mass., 1957, pp. 209-227, and in his paper "Costs, Freight Rates, and Location Decisions in the USSR" in *Value and Plan: Economic Calculation and Organization in Eastern Europe,* edited by Gregory Grossman, Berkeley, 1960, pp. 322-337.

[13] Iu. I. Koldomasov, *Osnovy planirovaniia perevozok na zheleznodorozhnom transporte* [The Principles of Planning Shipments in Railroad Transportation], Moscow, 1949, Table 22, p. 155.

the beginning blocks of the scale placing coal and coke, iron and other ores, and pyrites on the same basis of 12 kopecks per ton-kilometer for hauls up to twenty-five kilometers. The highest basis is shown for potatoes at 22 kopecks. In many instances, the same rate per ton-kilometer is continued up to fifty kilometers, but on peat, shales, and sugar beets the rates per ton-kilometer are lower for between twenty-five and fifty kilometers than they are for under twenty-five kilometers. Compared with average revenues somewhat above 5 kopecks, these high short-haul rates are designed to divert very short-haul traffic to motor trucks. After fifty kilometers the rates taper down, reaching a minimum rate per ton-kilometer at various lengths of haul ranging from 6.67 kopecks at 150 kilometers for peat to 3.6 kopecks for coal and coke at 1,500 kilometers.[14] Ores, however, reach a minimum of 2.9 kopecks at 700 kilometers and other commodities reach varying minima at other lengths of haul. Beyond the distance at which the minimum rate per ton-kilometer is reached, inverse taper is applied and the ton-kilometer rate gradually increases with distance until the maximum rate is attained at 3,000 kilometers. Thus the ton-kilometer rate for coal is 4.02 kopecks over 3,000 kilometers and for ores 4.47 kopecks. For peat the rate reaches 12.51 kopecks at this distance. The character of the commodity and its availability (distribution territorially) obviously have affected the choice of distances at which the minimum ton-kilometer rates apply. The application of increasing ton-kilometer rates to growing lengths of haul can increase the actual rate very rapidly. Inverse taper, thus, can be a strong deterrent to "hauls of excessive length" which the Soviets attempt to keep under control, just as the high short-haul rates can be relied upon to encourage the relief of rail transport by trucks in movements within terminal districts and elsewhere where truck movement is likely to be more economical. As will be observed later, the monthly planning of traffic also has its effect and establishes norms for the selection of the several available types of carrier.

In order to encourage movement by water carrier, whether on the rivers or in the coasting trade, and in recognition of the lower costs of water transport for hauls of equivalent length, water carrier rates per ton-kilometer are generally fixed 30 per cent below those established for rail hauls. This does not mean, however, that there is any

[14] By Western standards this may be considered a very long haul for coal, but it can be explained by Soviet geography which lacks a Great Lakes system and effective east-west water routes and has to cope with the remoteness of some heavy industry from appropriate grades of coal.

fixed differential between rail and water rates, as frequently prevails in the United States where rates per ton between fixed points are related rather than ton-kilometer rates.[15] On the contrary, since water routes are usually longer than rail routes between any two points, the differential will be less and, in the case of highly circuitous water routes, the rates by water may actually exceed those by rail. Thus, for gasoline from Syzran to Moscow a river haul of 1,913 kilometers replaces a rail haul of 914 kilometers and the water rate exceeds that for rail. A similar phenomenon is observed for flour from Gorky to Leningrad where a water haul of 1,603 kilometers replaces a rail haul of 1,145 kilometers. Or again in the mixed rail-water haul from Nizhnedneprovsk to Orsha for rolled iron and steel transshipping at Gomel, a joint rail-water route of 1,169 kilometers replaces an all-rail route of 1,005 kilometers and the resulting charges are higher, despite the reduction of the rail transshipment and water rates by 30 per cent for such joint hauls.[16]

Because of the inferior service available by water—due partly to the slowness of navigation and partly to the delays in transshipment—more direct methods have been deemed necessary to divert traffic from rail lines to parallel water routes during the navigation season.[17] Whereas Western countries consider that reduced seasonal rail rates are necessary to meet water competition and retain business for the railroads, the Soviet authorities decree increased seasonal railroad rates on selected routes for particular commodities in order to discourage the use of rail routes and encourage water hauls.[18] Selected increased rates are also named in particular instances to discourage distribution of commodities over exceptionally long distances and to discourage cross hauls. For example, the rates were increased 100 per cent for coal originating on the Tomsk and Karaganda Road and moving to stations west of Kuibyshev and Ul'yanovsk. An increase of 50 per cent

[15] In our experience a widening of the differential has frequently diverted traffic—even at times high-grade traffic—to water routes despite the slower and less frequent service and the greater probability of loss or damage. For an illuminating discussion, see John L. Hazard, *Crisis in Coastal Shipping: The Atlantic-Gulf Case,* Austin, 1955, Chapter IV.

[16] An extensive table of comparisons is given in Koldomasov, *Osnovy planirovaniia,* Appendix 3. The 30 per cent concession for combined rail-water routes is referred to as privileged and is designed to encourage short-hauling of the railroads by effecting transfer to water for completion of the hauls.

[17] The short navigation season imposes an unusual bar to inducing shippers to a seasonal shift of practices. There is some evidence that the efficiency of water operations is substandard and that the administration is less than active in soliciting water routing of eligible business.

[18] Between a limited number of points a 100 per cent increase in rail rates applies for all commodities during the navigation season.

was prescribed for all loads of sugar beets in excess of 300 kilometers. Some seventy-one such special rates were established by a decree of the Council of Ministers on September 9, 1948, in what appears to be a continuing practice, some designed to deal with the availability of water routes during the navigation season, others to apply at all times to hauls considered wasteful. A detailed list and description of these increases are shown in Koldomasov.[19] Rate disparities of the magnitude that result from grafting these special decrees upon the normal tariff system cannot help but discourage to some extent undesired rail hauls, although the inflexibility of the system because of the administrative impediments in the way of rate changes by ministerial decree prevents reflection of conditions in detail as well as prompt variation with changes of circumstances and may, thus, occasionally pull in wrong directions. More direct methods are also employed which will be considered at a later point.

Whatever the effects of the efforts to influence transportation demand through rates, it is important to note the absence of the stimulus, characteristic in Western countries, that results from accommodation of rate structures to competitive influences. The Western tradition is not to discourage, but to encourage, transportation, and in a competitive system this produces all manner of rate stimulants designed to expand areas of distribution, permit cross penetration of markets, and enhance the length of haul. Grouping, the establishment of common points, equalization, and the use of differentials that offset production costs or other factors are noteworthy for their absence in the Soviet scheme. Low rates on basic commodities to encourage industrialization have generally been applied, but have usually adhered to the distance principle. To the extent that these practices have successfully promoted transportation in the West, their absence from Soviet policy must be judged to produce a difference in traffic conditions.

Zoning

Zoning of freight movement and of commodity distribution is a practice with which Great Britain and the United States became familiar during the two world wars. In neither country was it applied vigorously or extensively and it has generally been considered as a substantial failure.[20] Tolling was also used during wartime in the

[19] *Ibid.*, Appendix I.

[20] Zoning of coal by the U.S. Railroad Administration in the first war is generally pointed to as the outstanding failure. Rigid administration and failure to accommodate to the various qualities of coal are the chief elements in the indictment. They are probably weaknesses which are also found in the Soviet practice.

United Kingdom. Tolling is the interchanging of brand names so that distribution can be zoned by manufacturers associated in tolling agreements without affecting the competition of brands on the market. In a very modest way it was introduced voluntarily by some manufacturers in the United States during the inflation after World War II. Such a complication does not exist in the Soviet Union.

Zoning is, however, an integral part of Soviet planning for traffic movement. It takes many forms and in some instances is mandatory, while in other instances it is a plan for general observance subject to exceptions. For coal, stations are named on particular railroad lines beyond which a producing field or mine may not ship. They represent, in effect, transportation divides and appear to be calculated according to not only the rail mileage, but also the heating value of the coal which affects the tonnage to be moved.[21] Exceptions are said to be made for special quality coals for metallurgical and chemical purposes. The routing plan for cement specifies the railroads, portions of railroads, and terminal districts which may be served from origins on the various railroad systems subject to adjustment of market regions of varying demands to available supply. Molding sands are to be distributed from particular pits to named *oblasti.* A joint decree of the Ministries of the Food Industry and of Transportation governs the distribution of salt from origin stations, specifying the rail lines to which delivery may be made from such origins. The theory for analyzing traffic movements with a view to developing limits is reasonably well worked out. What it is impossible to ascertain is the effect of these measures, although it appears that they must have some effect in conserving transportation.

Despite considerable discussion among transport economists and others, despite a multitude of decrees, and despite planning techniques designed to analyze desired movement in advance and give it direction, Soviet officials never cease to criticize wasteful transportation, excessive hauls, cross hauls, and the like. Techniques are evidently far from perfect in application and considerable initiative still rests with local shipping units. This initiative is not always employed in ways calculated to satisfy railroad officialdom or the Ministry. Thus, Beshchev, the Minister of Transportation, complained in 1954 that too little progress had been made in eliminating irrational hauls,[22]

[21] What is theory and what is actual practice is difficult to discern in this and other matters.

[22] Speech before All-Union Conference of *Aktiv* of Railroad Transportation Personnel, condensed from *Pravda* of May 19, 1954, in *Current Digest of the Soviet Press*, 1954, No. 21, p. 4.

while Kaganovich was more vehement and cited many examples. Railroad transport "is still forced to haul excess freight and to make extremely long, counter, and other thriftless movements on which huge sums are expended. Shippers and consignees are not much interested in where a commodity comes from—they are not interested in rates nor do they protest the long distances. They will do anything to get the commodity."[23] The polemics of Kaganovich emphasize examples of inefficiency which can always be found in any large and complicated system; the writings of the analysts describe the system as it is supposed to work. Somewhere between is the actual position and it must be judged that the measures here loosely termed zoning have their constructive influence, although if Western experience is any guide at all, this is of the order of 2 or 3 per cent of traffic volume rather than any more impressive figure.

Of more practical importance is the readiness to embargo non-priority traffic, sometimes for extended periods, in a way that no carrier under a competitive system could. This is sometimes to relieve a particular line or railroad, but may have more extended application. It provides a means to regulate traffic at the several peaks and at all times of transport shortage while maintaining essential traffic flows. And it is an effective method for enforcing zoning schemes or other studied limitations.

Control of Traffic Variation Through Storage at Origin

A consequence of the failure to provide capacity adequate for peak demands is enforced storage at origin, as a result of which backlogs customarily build up that are worked off in the spring. This is a situation of such long standing that it is apparently not looked upon as an object of comment save when the shortfall in capacity prevents moving the accumulations before subsequent seasonal increases in goods available for shipment develop. Regularity in rail traffic is highly prized and efforts are made to expand storage at origin to promote this result. Moreover the building of winter stocks of coal and metallurgical raw materials at the consuming plants is emphasized

[23] Speech before the Supreme Soviet Session, Council of the Union, reported in *Pravda*, April 27, 1954, p. 7, in *Current Digest of the Soviet Press*, 1954, No. 17. One of the more astonishing examples which he gives is that about 30 per cent of rail ton-kilometers in the coal traffic were produced in handling that portion of the coal traffic which moved beyond 1,800 kilometers. Moreover he cites an increase in the coal moved beyond 2,600 kilometers from 5.9 per cent of the total in 1952 to 7.1 per cent in 1953.

in rail as well as water movements.[24] Timing of movements for prices and speculative purposes or with a view to maneuvering the railroads into a delay claim appears to have no place in the distribution pattern, nor does storage on cars in advance of shipping instructions. Considerable emphasis appears to be given to the country storage of grains, although a distinct change in the composition of rail traffic has reduced the effect of the agricultural crop cycle on the seasonal pattern of traffic.[25] It is impossible to compare the contribution that storage makes to an even transport flow in the Soviet Union and in Western countries. There is evidence, however, suggesting a significantly greater role in the Soviet Union.

Planning of Traffic Movement

Through the regional Shippers' Advisory Boards railroads in the United States receive quarterly advance estimates of carloadings, which are helpful in car distribution and in other matters involving the effective movement of traffic. Soviet railroads have the advantage of a formal planning procedure, which very likely comes closer to an accurate forecast and which also serves many other useful purposes in mitigating the burden of freight traffic and providing for its effective coordination. These elaborate planning techniques with their excess of paper work cannot be expected to be without effect, for they involve detailed cooperation between the railroads and the shipping ministries and provision is made for check upon plan fulfillment. The detail of planning provides for the establishment of numerous norms for car handling, consolidation of shipments, and other matters tending toward more efficient use of the transport plant. An analysis of plans will disclose direct and indirect cross hauling and excessive hauls where the jurisdiction of a single railroad is not broad enough to comprehend them. Review by shipping ministries then becomes possible in order to secure superior performance in later plan periods.

[24] Such stocking is a necessity at rail-supplied plants to avoid undue delay of railway cars because of frozen lading. No data have come to view which disclose its magnitude.

[25] The following data (computed from series C-8 in Appendix C) are illustrative:

	Per Cent of Total Ton-Kilometers	
	Grain	Coal and Coke
1913	15.1	19.4
1940	7.9	35.0
1950	5.1	30.1
1958	6.2	26.8

The plan procedure was modified in 1939 to provide for monthly shipment plans which tie together origin and destination and which are to be prepared by the shipping ministries and subject to review by the railroads.[26] Emphasis is placed on the holding and consolidation of volume from particular origins to particular destinations in multiple-car consignments up to full trainloads, on the exchange of supplies among enterprises for the service of consuming ministries in such a way as to produce minimum hauls, and on similar matters affecting the efficiency of equipment use. Prospective short-line routings are checked by the rail carriers against line capacity, and prospective overloads are coped with by modifying operating practices or resorting, where necessary, to indirect routing of a portion of the volume over noncongested lines. As with other aspects of Soviet technique for traffic control, evaluation of the effects of planning processes is impossible from available data. Since the whole process is directed toward obtaining efficient use of the transport plant, however, it can only be presumed to be of some help in this direction.

Comparison of Soviet and U.S. Average Hauls

Notwithstanding all efforts to minimize average hauls and avoid excessive transportation, Soviet geography and Soviet industrial policy, particularly in its early emphasis upon large-size plant, have resulted in longer average rail hauls than in the United States. From the point of view of minimizing rail hauls, the Soviet distribution of heavy resources is unfortunate, but Soviet industrial policies have tended to exaggerate this disadvantage, as is well illustrated by the disregard of necessary long hauls in the Ural-Kuznetsk Combine.[27]

It is of vast importance, also, to note fundamental differences in the transportation geography of the two countries in order to evaluate the quality of Soviet transportation. The Soviet Union lacks a Great Lakes system; it lacks a river route for a main channel of heavy commodity flow which is as satisfactory as the Monongahela-Ohio-Kanawha system; it lacks reasonably direct coastwise transportation. Were it not for the Great Lakes system, the length of the rail haul of some 130 million tons of ore, coal, and grain in a busy year would have

[26] Koldomasov's book (*Osnovy planirovaniia*) is in greater part devoted to a description and discussion of plan techniques but contributes little to their evaluation.

[27] See Hunter, *Soviet Transportation*, pp. 47-50, and Franklyn D. Holzman, "The Soviet Ural-Kuznetsk Combine," *Quarterly Journal of Economics*, August 1957, pp. 368-405.

to be tripled.[28] In the absence of direct connecting coastwise transportation, the rail haul of some 40 million tons of tidewater coal would be roughly doubled, while some 200 billion ton-miles of petroleum transportation would have to be accommodated by a new trunk pipeline net or moved by inland water-rail routes in the absence of the Gulf-Atlantic coastwise service. In the absence of these water routes, were American industry distributed as at present, our average rail haul would be increased some 20 per cent. But the development of our resource pattern would have followed a different sequence had the stimulus of the lakes been absent.

The comparison of average hauls in Table 12 below is, for the most part, limited to the prewar period. The rapid rise of average rail hauls in the United States since the war is largely the result of a phenomenal growth of motor transport which has no parallel in the Soviet Union and which has diverted a large tonnage of short-haul business.[29]

TABLE 12

COMPARISON OF AVERAGE HAUL ON U.S. AND SOVIET RAILWAYS, 1928-39, 1950, 1959
(miles)

	U.S. Railways		*Soviet Railways*
	Actual Mileage[a]	Short-Line Mileage[b]	Tariff Mileage[c]
1928	318	286	374
1929	317	285	376
1930	316	285	351
1931	329	296	368
1932	347	312	395
1933	342	308	395
1934	337	303	406
1935	341	307	415
1936	337	304	418
1937	337	304	429
1938	356	321	449
1939	351	316	442
1950	416	375	451
1959	445	401	506

SOURCE: U.S. data from *Statistics of Railways*, I.C.C. for corresponding years; Soviet data from series C-3 in Appendix C.

a All U.S. data rounded to nearest mile.

b Reduced by 10 per cent to adjust approximately to short-line mileage. Occasional studies have demonstrated circuity in the carload freight service ranging from 12 to 13.8 per cent. See Stuart Daggett, *Principles of Inland Transportation*, New York, 1955, p. 368, and *Transport Economics*, January 1956, pp. 5-7.

c Converted into miles at 1.6 kilometers to the mile for ease of calculation, the underlying data being somewhat rough for most years.

28 Assuming topography, in the absence of the lake system, permitted direct diagonal lines across the lakes region with the industry located upon such routes.

29 Reporting motor common carriers, however, now show a traffic-revenue relationship which implies an average haul of approximately 200 miles.

Hence comparison with USSR data are difficult to interpret in the postwar period. The several postwar observations given, however, illustrate that Soviet average hauls continue above those of U.S. railroads.

Composition of Freight Traffic

The term "composition" of freight traffic denotes the proportions of various commodities and types of freight embraced in the total traffic. It is a necessary object of study if a system of transportation is to be understood because the character of the traffic affects the plant which must be provided, the type of equipment needed, the character of service required, the operating methods, and the operating results. Moreover, for the purposes of this study, it is of independent value to gather the available data on commodity composition of traffic since such information may assist in the evaluation of production data. Especially where railroad traffic represents so large a proportion of the whole, its composition may convey a good idea of the make-up of the economy. It should be recalled, of course, that data on the traffic of particular commodities are likely to be affected by the same infirmities as the total traffic data. Moreover, the Soviet classes of commodities do not correspond, in many instances, with the classes employed elsewhere, so that comparison is difficult and not entirely conclusive.[30]

Composition of traffic can be studied in carloadings, tonnage originated, tonnage handled, tonnage terminated, ton-mileage, and

TABLE 13

COMPOSITION OF SOVIET FREIGHT TRAFFIC, FIVE-YEAR INTERVALS, 1930-58
(per cent of total annual tons originated)

	1930	1935	1940	1945	1950	1955	1958
Coal and coke	17.3	24.4	25.7	36.0	32.0	30.7	29.6
Petroleum and petroleum products	5.5	5.8	5.0	5.4	5.2	6.1	6.9
Ores	4.1	6.7	5.6	4.5	5.7	6.6	6.7
Ferrous metals	3.5	4.9	4.6	5.4	5.2	5.7	5.4
Lumber building materials	13.0	10.9	7.2	6.7	8.7	7.4	7.5
Firewood	6.3	4.7	3.9	4.4	2.3	1.3	1.1
Mineral building materials	10.8	14.3	18.9	10.6	18.9	19.4	20.0
Grain	10.2	7.7	7.5	5.1	4.7	4.6	4.4
Other freight	29.3	20.6	21.3	21.9	17.5	18.2	18.1

SOURCE: Series C-7 in Appendix C.

[30] Detailed breakdown by commodities is not available after the middle 1930's, nor is the precise content of the present grouping fully defined. Certain changes in classification have occurred, but this is true of other countries as well.

revenue. Average haul, which may be computed from two of these sets of data, as well as average carload may also have their use. For parallel study with production data, tons originated or terminated should be the most useful, hence we begin our analysis with a consideration of these data. Table 13 gives the Soviet data. It will be observed that the composition has been changing over the twenty-five-year period represented here and a more detailed study could be made if it served a useful purpose. It will be noted especially that the share of coal and coke has grown, that it was more than double the 1930 share in 1945 and thereafter fell off somewhat. Petroleum shows a fair stability up to 1950, but an increase thereafter, the actual 1958 tonnage originated being more than two and a half times that of 1950.[31] Although ores stood below the middle 1930's through 1950, the share of ferrous metals has tended to grow. But in the form presented here the data are not well adapted to an analysis of the significance of traffic composition from the point of view of operations. Both a rearrangement and a comparison with U.S. composition will shed some light on that significance. Coal and coke, ores, and petroleum are all included in the U.S. data under products of mines. Petroleum products are, however, for the most part included in manufactures. Mineral building materials for the most part belong in the products of mines category, but such items as cement, brick, and tile are included under manufactures in the U.S. classification. The sum of lumber building materials and firewood in the Soviet classification should come close to approximating our products of forests. As animals and products are included under other freight in the Soviet classification, there is no Soviet equivalent to this U.S. classification. Recast under these several categories, and with the qualifications noted above, we obtain the Soviet figures shown in Table 15 below.

To make the U.S. data more nearly comparable, we must also adjust them. The unadjusted figures are shown in Table 14. In effecting adjustment, we may reduce the products of agriculture by 35 per cent to represent items presumably not covered in the Soviet grain category, for the proportion of grain and grain products in the United States products of agriculture fluctuates in the neighborhood of 65 per cent. This item, together with animals and products and less-than-carload freight, may be included in the other freight category which we have

[31] Actually coal and coke appears to have reached a peak in 1947 at 37.2 per cent of total tons originated. Ton-kilometrage of petroleum increased more rapidly than tonnage and in 1958 stood at three times the 1950 figure.

TABLE 14

COMPOSITION OF U.S. FREIGHT TRAFFIC, FIVE-YEAR INTERVALS, 1930-58
(per cent of total annual tons originated)

	1930	1935	1940	1945	1950	1955	1958
Products of agriculture	9.6	9.7	8.8	11.2	9.5	9.6	12.3
Animals and products	2.0	1.9	1.5	1.7	1.1	0.9	0.8
Products of mines	55.7	56.3	56.5	51.4	55.2	54.6	52.9
Forest products	6.0	5.4	5.8	5.3	5.8	5.9	6.1
Manufactures and miscellaneous[a]	24.1	24.9	25.9	28.9	27.6	28.5	27.5
Less-than-carload	2.6	1.8	1.5	1.5	0.8	0.5	0.4

SOURCE: *Statistics of Railways in the United States* for 1930, 1935, 1940, 1945, 1950, 1955, and 1958, Interstate Commerce Commission.

[a] Includes traffic consolidated by freight forwarders and tendered in carloads.

renamed "manufactures and miscellaneous." Thus recast, the comparable figures are shown in Table 15.

We may effect a further adjustment by breaking down the United States products of mines category and taking out of manufactures and miscellaneous certain items which we presume are covered in the Soviet products of mines category as developed above. Following this process, we combine anthracite and bituminous coal and coke, bring together crude petroleum and refined petroleum products including lubricating oils, sum up the several categories of ores and concentrates, and bring together as "mineral building materials" sand, gravel, stone, artificial stone, lime, plaster, brick, cement, and tile. Thus we are able to break down the products of mines category into elements which should reasonably coincide with the Soviet items which we grouped above under this head and we may transfer the remainder of the United States classification to manufactures and miscellaneous. The result, as given in Table 16, should represent a reasonably comparable tabulation. It will be observed that the change between the two broad categories is not great, but it reduces the apparent difference between the United States and the Soviet traffic composition.

What, if anything, may be learned from so rudimentary and imperfectly matched a classification? Certain of the groups are relatively homogeneous in their transportation characteristics. That is true of the products of mines category, with the exception of very small tonnages of certain nonferrous ores which are included. These commodities are of high density and relatively low value, and may be handled in bulk in quantities appropriate to the capacity of the cars. Individually they are one-way commodities and they will seldom be

TABLE 15

COMPOSITION OF U.S. AND SOVIET FREIGHT TRAFFIC, FIVE-YEAR INTERVALS, 1930-58
(per cent of total annual tons originated)

	1930		*1935*		*1940*		*1945*		*1950*		*1955*		*1958*	
	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.
Products of mines	37.7	55.7	51.2	56.3	55.3	56.5	56.5	51.4	61.8	55.2	62.8	54.6	63.2	52.9
Forest products	19.3	6.0	15.6	5.4	11.1	5.8	11.1	5.3	11.0	5.8	8.7	5.9	8.6	6.1
Grain	10.2	6.2	7.7	6.3	7.5	5.7	5.1	7.3	4.7	6.2	4.6	6.2	4.4	8.0
Manufactures and misc.	32.8	32.1	25.5	32.0	26.1	32.0	27.3	36.0	22.7	32.8	23.9	33.3	23.5	33.0

TABLE 16

COMPOSITION OF U.S. AND SOVIET FREIGHT TRAFFIC, FIVE-YEAR INTERVALS, 1940-58
(per cent of total annual tons originated)

	1940		*1945*		*1950*		*1955*		*1958*	
	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.	Soviet	U.S.
Coal and coke	25.8	36.8	36.0	34.0	32.0	32.4	30.7	29.0	29.6	28.9
Petroleum and petroleum products	5.0	5.4	5.4	4.3	5.2	3.2	6.1	2.9	6.9	2.8
Ores	5.6	8.7	4.5	7.3	5.7	8.5	6.6	10.1	6.7	7.9
Mineral building materials	18.9	8.0	10.6	6.7	18.9	12.2	19.4	14.9	20.0	15.7
Total products of mines	55.3	58.9	56.5	52.3	61.8	56.3	62.8	56.9	63.2	55.3
Forest products	11.1	5.8	11.1	5.3	11.0	5.8	8.7	5.9	8.6	6.1
Grain	7.5	5.7	5.1	7.3	4.7	6.2	4.6	6.2	4.4	8.0
Manufactures and miscellaneous	26.1	29.6	27.3	35.1	22.7	31.7	23.9	31.0	23.5	30.6

handled, except petroleum, in other than open-top equipment. The volume of movement, especially in the case of iron ore, coal, and coke, is great enough frequently to permit forwarding in multiple-car or trainload lots from a given mine to a particular consuming installation while employing cars of the greatest capacity available.[32] Given a large flow over a particular route, this traffic is the most favorable type to handle, enabling the development of heavy trainloads moving through yards and terminals adapted to the specialized flow. The rail costs are the lowest for such flows and the business, when well organized, is characteristically enormously profitable even at a level of rates quite low relative to the average.[33] In the Soviet case, the long average haul adds to the importance of the traffic in this category and presents the railroads with a more advantageous set of circumstances for attaining economy per ton-mile.

The forest products category is less homogeneous. It appears that the Soviet category is much more largely made up of logs, pulpwood, and firewood rather than the dressed and finished lumber in the American category. Consequently a larger portion can be satisfactorily loaded in open-top equipment and the quality of equipment furnished for loading is of less significance. This traffic, too, has the important

[32] This tends to promote the lowest ratio of tare weight to gross weight of any loaded movements in rail service.

[33] The continued prosperity of the American bituminous coal roads and of the ore roads, despite their short hauls, is a case in point. But the British coal roads during an earlier period were also excellent examples both in the Welsh fields and in the Midlands.

advantages of being relatively free from risk in transit, having relatively low value, and being able to load under most circumstances up to the full capacity of the car. On the other hand, open-top loads of logs, lumber, and poles are notorious for their propensity to shift in transit and thus to occasion delay at intermediate yards for readjustment of loads. When, however, the traffic is available in large volume, as from most producing regions, it produces desirable tonnage which can be handled with considerable economy of equipment.

Grain is also low-grade, heavy-loading traffic which frequently makes up into trainloads early in its movement, but it requires high-class closed cars for safe movement in bulk over long distances and it suffers from seasonality. As the Soviet harvest is spread over a longer period because of the machinery situation and since storage at origin is stressed, the seasonal characteristic has a less serious effect than on the roads of the western United States or of Canada.[34] But it nonetheless has an undesirable effect on this traffic which is mitigated in the Soviet case because the railroads do not serve harvesting over a dense network of branches in the grain-growing territory to the same extent as in most other countries with commercial grain agriculture. Moreover, the bulk of line-haul transportation the year round is performed by rail, hence the grain lines do not dry up at other than harvest time, while the relatively low yield and spread of the harvest tend to insure a less concentrated load. These two factors mean that the facilities necessary for normal traffic are more nearly adequate for the peak of the grain movement than is generally the case elsewhere and, along with the spread induced by local storage, they render unnecessary proportionately large advance accumulations of cars held idle awaiting grain loading. Except for the loss of car time in such accumulations, the grain traffic normally makes intensive use of car equipment, provided cars are not loaded when the ability of the terminal elevators to unload them promptly at destination is in doubt. This factor seems to be well under control in the Soviet case. It is worth noting that in each of the postwar years shown Soviet grain traffic appears to have been a smaller proportion of the whole than in the United States.

The manufactures and miscellaneous category is a catch-all of vast scope, so varied in its composition as to permit little useful comment.

[34] The Soviet position is more nearly comparable to ours before the first war. Given dry weather, the U.S. harvest may now be concentrated within a week's time in any particular loading area. Hence virtually all the cars required to load it must be stored in the loading area in advance, often some weeks in advance because of the unpredictability of the time of arrival of grain at country elevators.

Since it is much more limited in American statistics and since a rather detailed breakdown is also available, something can be said of its transportation characteristics. But our adjustments have necessitated bringing in livestock and products, much of the agricultural category, miscellaneous items from products of mines, less-than-carlot traffic, and forwarder traffic, since we are not able to take out these components of Soviet traffic. Yet it is in the relationship of this category in the two countries, as well as in its movement over time in the Soviet Union, that we may find some contrasts and developments of significance. Hence we cannot dismiss it, despite its heterogeneous composition.

It is to be observed that at five-year intervals since 1930, the shares of this category in the total in the Soviet Union have been consistently smaller than those for the United States, by from 3 to nearly 10 percentage points and, although the lag has diminished a bit since 1950, it remained greater in 1958 than in 1940. Despite our limited knowledge of Soviet traffic and the extensive adjustments it has been necessary to perform, it appears likely that this catch-all category has about the same commodity coverage in both countries. In any event, no further adjustment is possible from the available data. Hence it appears probable that, at least since the second war, Soviet minerals traffic has represented a larger proportion of the whole than in the United States, while over the entire period since the early 1930's manufactures and miscellaneous traffic as put together above has lagged. Among the important items making up the category, ferrous metals can be separated, although we cannot be sure that the separate commodity descriptions put together from the U.S. statistics are not more inclusive than this Soviet category. Such a comparison suggests that ferrous metals in the United States have consistently represented a larger proportion of total rail traffic, except in years such as 1958 when the steel industry was at a lower than average level, but the reader is cautioned to remember that rail traffic in the U.S is much less important and much less representative of the whole of domestic transportation than is the case in the Soviet Union.[35] Particularly is it to be noted that a very large volume of manufactured iron and steel moves in the United States by truck. The comparison also indicates that there has been a change over the 1940-58 period in

[35] The comparative data for ferrous metals as a percentage of total rail traffic are:

	1940	1945	1950	1955	1958
Soviet	4.6	5.4	5.2	5.7	5.4
U.S.	6.4	6.2	6.6	6.9	5.2

the position of the two countries in ferrous metals traffic as a proportion of the manufactures and miscellaneous category constructed earlier. Whereas in 1940 this proportion was smaller in the Soviet Union than in the United States, by 1945 the position was reversed and it has remained so, although the 1950 and 1955 data do not reveal a widening of the gap, while 1958 does not afford a good basis for comparison because of the reduced activity in the U.S.[36] The change is a modest one and must not be accorded great significance, although the Soviet share is probably understated in comparison with the U.S. one.[37] It appears likely that vehicles of all kinds as well as agricultural implements and parts stand higher in the U.S. composition, despite the fact that the greater part of this traffic moves in the United States by other methods of transportation. Beyond this, it is not possible to indulge in further speculation from the limited data except to note the probability that in food products and in consumer goods generally there is a sharp difference in quality, limitation of variety, and form of packaging which simplifies the problem of transportation. The Soviet items probably move in larger unit packages, are of higher unit density, and are frequently in a less final state of manufacture. Staples in all likelihood form a greater proportion than goods finely tailored for a cultivated demand attuned to style characteristics and brand differentiation. These differences, while probably of modest significance, nevertheless point to a manufactures and miscellaneous traffic which it should be possible to load more rapidly and readily in the car—traffic, in short, which is somewhat more favorable to railroad efficiency.[38]

The heavier proportion of mineral traffic is, of course, favorable to heavy car and train loading and, except under unusually bad weather conditions, is favorable also to the rapid loading and unloading of cars. This tendency is reinforced by the less fine classification of these items by size, chemical composition, and grade, and by less variety in the brick and tile list. It is especially notable that mineral building materials have far exceeded the similar category in the

[36] Ferrous metals traffic made up the following percentages of manufactures and miscellaneous traffic:

	1940	1945	1950	1955	1958
Soviet	17.6	19.8	22.3	23.9	22.9
U.S.	21.6	17.6	20.8	22.2	17.0

[37] Interstate Commerce Commission category 583, "Manufactured Iron and Steel," is particularly likely to include items not embraced in the Soviet category.

[38] It should be observed that, insofar as tonnage originated is overstated, it is most likely to be of importance in this category.

United States even though care has been taken to include in the U.S. compilation all items that could reasonably be included under the Soviet caption. It is difficult to account for so great an excess, but if it is accepted at face value it represents a category primarily composed of commodities of highly desirable transportation characteristics conducive to heavy carload and to rapid loading and unloading of cars, particularly when handled in bulk. It is also noteworthy that lumber, for the most part a commodity with desirable loading characteristics, has stood at nearly twice the proportionate U.S. level over almost the whole period selected for study and that examples of this traffic cited in the Soviet rail press give evidence of excellent loading achieved in practice. Like the grain traffic, the lumber traffic tends to be concentrated at limited points of delivery and interchange to the railroad system and hence would appear to be originated under somewhat more favorable circumstances than is much of the U.S. lumber traffic.

The available data are so inadequate that caution is necessary in drawing conclusions. Nevertheless, the following comments on the over-all composition of Soviet rail freight traffic would appear to be justified:

1. The similarities are more apparent than the differences, but the latter may be of sufficient magnitude to have some favorable effect on the rail operating task.

2. Soviet products of mines appear to have exceeded the proportion which they have represented of U.S. rail traffic since the war and to have been not far behind the U.S. proportion between 1935 and 1945. This growing disparity is the most significant difference between the two compositions and it is favorable to high utilization of cars and motive power, as well as of track capacity in those areas where minerals are preponderant in the traffic. The disparity by 1950 had certainly become great enough to have a favorable effect upon Soviet rail operations.

3. Forest products have consistently represented a greater proportion of Soviet than of U.S. freight traffic, and this also is to be regarded as a somewhat favorable circumstance.

4. Grain has been less important in the United States than in the Soviet Union over most of the period, although 1945, 1950, 1955, and 1958 show the opposite relationship because of exceptionally heavy grain movements in the U.S. during those years and the persistence with which grain remains "rail bound" in the face of the progressive diversion of many types of tonnage to other forms of transport.

5. Manufactures and miscellaneous traffic is a heterogeneous category about which not much can be said but which appears, since 1930, to have been a bit lighter in Soviet than in U.S. traffic—significantly so by 1955—and to have represented traffic on the average in a cruder state of manufacture, of more limited variety, moving in large packages or in bulk and in relatively large lots, all factors which are of some advantage to the carriers.

6. The ferrous metals category is probably lighter in the total composition of Soviet traffic, but heavier when expressed as a percentage of the manufactures and miscellaneous category to which it belongs. This, with other factors, helps to make that category a less difficult one for carriers to accommodate.

7. In sum, the differences in composition which the highly inadequate data suggest appear to be of some, but not of great, significance from the point of view of their effect on railway operations.

8. There is a lingering doubt, however, whether the overstatement of tonnage referred to earlier is not greater in the manufactures and miscellaneous group than in the products of mines and timber groups because significant underloading is more readily visible in most of the traffic in these last two groups, thus resulting in an actual position possibly more favorable than the data disclose.

9. What we are discussing here is the composition of *railroad* traffic in the two countries. Rail traffic in the Soviet Union, if accurately stated, should fairly represent the composition of the economy. In the United States it does not, for railroads account for less than half of the total movement and it is probably correct to say that as much manufactures and miscellaneous traffic is originated and handled to destination by truck as by rail while the great bulk of all petroleum, both crude and refined, is originated and handled to destination by transport other than rail. It is also likely that the general types of manufactures and miscellaneous traffic still on the railroads, while not representative of the whole, are reasonably similar to the types which characterize Soviet rail traffic in this category with the notable exceptions of forwarder traffic and a limited tonnage of high-grade consumer goods which probably have no counterpart in Soviet traffic.

CHAPTER 4

An Analysis of Soviet Railway Operation

The Nature of Soviet Railway Operations

USEFULNESS OF STUDY

Of the several forms of transport, the railways alone afford a body of interrelated data that permit some internal check upon the probable accuracy of the published figures and also make possible an analysis of the methods by which the traffic performance is achieved.[1] Moreover, at least something is known of the source of many of these data; hence an impression can be formed of the character of the error which they may reflect and occasionally some judgment of its magnitude can be risked. This is of particular importance since the railways account for by far the greatest part of freight and passenger traffic and it is around the railways' returns that there has been the greatest controversy in Western countries.

Distrust has been generated by performance factors, particularly car turnaround, which may be viewed as impossible by Western standards. But, in general, the superficial picture is one of a traffic so large as to be inconsistent with the relatively small railway plant operated—small in mileage as well as in motive power and equipment. Characteristically this is interpreted in the West as a sign of weakness, despite the considerable period over which it has persisted without significant breakdown of performance. Moreover, the Soviet railroads have been judged by Western standards and found wanting in efficiency because they employ obsolescent motive power and equipment, render a service wanting in accommodation to shippers' desires, and show a low labor productivity. The question may be raised, however, whether these standards are appropriate to the Soviet scene in the light of over-all Soviet objectives. Moreover, economic inefficiency reckoned in Western terms, if it can be shown to exist, casts little light on (1) the physical capability of Soviet transportation which should be a prime interest of Western students when appraising the military capability of the Soviet Union or (2) the adjustment to patterns of resource availability as they have existed in the Soviet Union during its progress from a state of economic underdevelopment. Hence we must embark upon our examination from a somewhat different point of view.

[1] It may also be re-emphasized that they account for from 89 to 90 per cent of Soviet intercity freight traffic as well as for the great bulk of the passenger traffic.

RELATIONSHIP OF RAILWAY DEVELOPMENT TO THE ECONOMY AT LARGE

A plausible argument can be made for the proposition that the Soviet railways have gone through three decades of development in which their course has been charted and held in good correlation with the over-all Soviet economy. If one postulates a situation in which: (1) labor is plentiful, but labor with good mechanical skills scarce; (2) engineering personnel is limited, but more by the quality of its training and its experience than by number; (3) heavy industry is inadequate for the demands made on it and there is a marked shortage of capacity to produce the heavy shapes and forms of steel that railroad development requires, and an even more marked shortage of heavy machining capacity to work to close tolerances; and (4) transport is to be regarded as a necessary service for industrialization, but is to be used in such a way as to make the minimum drain on all that is necessary for that industrialization, not in monetary terms but in physical resources and available human skills—then much that has occurred in the Soviet railways finds a ready justification. There are now signs of change that suggest that the balance of economic forces has altered sufficiently to make possible movement in directions already pursued in the West. These signs are to be found particularly in the refinement of steam motive power, the beginnings of dieselization, the planning of more extensive electrification of strategic routes, and developments in signaling and in the mechanization of yards. These developments suggest that concern over the inadequacy of petroleum resources has diminished, that labor has become less plentiful, and that the level of mechanical and engineering skills has improved. Of what, then, did this adjustment to Soviet conditions consist?

It has been said that the Soviet railways in recent years bear a marked resemblance to the North American railways of the early 1920's. There is an element of truth in this statement, but it cannot be accepted without qualification. Like American railways in the period before highway and air competition, the Soviet system is established upon the basis of moving tonnage in slow freight service, but there is even less differentiation in Soviet freight service than on the American railways of earlier times, for interrailroad competition is absent and, beyond what is necessary to the security of perishables, little concession has been made toward provision of fast freight services. To maximize line capacity, the objective is to operate a railroad at as nearly a constant speed as possible.

Any transportation system may be analyzed in its adjustment to the needs of the shipper in terms of three primary dimensions: the rates charged for specific services; the over-all speed between points; and the service amenities, which include frequency, reliability, size of shipment permitted, special parcels facilities, split pick-ups and deliveries, expediting, diversion and reconsignment privileges, and the privilege of holding for billing and other matters.[2] As already noted, the Soviet rate system is used as a tool to accomplish certain objectives. But relative to other prices, Soviet freight charges as measured by average revenues appear to surmount efficiently the barriers of distance in terms of cost. At the distances within range of average hauls, cost of transportation appears reasonably related to other costs. In average speed of movement the Soviet system also shows up well. While train speeds between initial and final terminals, including all delays on the road, do not compare favorably with present speeds in the United States, they are offset by faster movement through yards so that Soviet over-all times correspond well with those for similar hauls in the United States. Under the head of service amenities, however, virtually nothing is provided except, over most main routes, a high frequency of freight train service which arises naturally from the high density and concentration of the freight traffic and the relatively light net train load. By ignoring amenities that are forced upon carriers in a competitive system, Soviet railroads simplify their task considerably. And they go even further in this respect than the railroads of other countries in an earlier era, for they provide virtually no accommodation for the less-than-carload consignment and for peddler services,[3] thus forcing concentration into carload consignments and avoiding the waste of cars inherent in lightly loaded less-than-carload business.[4]

In the production of mass slow-speed freight transportation, the Soviet roads have worked with simple but rugged plant and have carried standardization to an extreme degree. For over twenty years three standard types of steam freight locomotive have represented virtually all the additions and replacements in the freight locomotive fleet, while two types of steam passenger power have sufficed for most needs, and special designs for switching work have not been required.

[2] The Soviet system escapes some of the complexity of a competitive system for, where it is necessary to hold a bank of cars at a port, segregation by large numbers of individual owners as well as by grade is generally not required.

[3] Peddler services consist of the delivery of less-than-carload consignments at intermediate stations from cars moving in local freight trains.

[4] The small two-axle car is, of course, very handy for smaller consignments within the range of its capacity. Some recent emphasis upon the necessity of improved service for small consignments appears to have been dissipated.

Major parts are interchangeable between the heavy freight and the heavy passenger power. Freight car types are distinctly limited in number and new construction has been consistently restricted to a very small number of standard designs. The variety to be found in the whole system is rather less than any individual large American railway would boast of, particularly in dimensions and door arrangements of box cars and dimensions and special equipment of gondolas. The specialized car finds no favor on the Soviet roads and is provided only as necessity dictates, e.g., in tank cars and refrigerator cars. Standard all-purpose cars are made do where shippers in a competitive economy would require better adjustment to their needs and would secure it. The standard open gondola serves not only bulk loadings but also much traffic which in the West would be loaded in covered cars. This lack of specialized cars is very helpful in keeping empty car-mileage at a low figure.

Soviet locomotive practice, as much as anything else, illustrates the adjustment of railroad equipment to the general economic position of the country. The freight power is generally of the 2-10-0 and 2-10-2 types, small wheeled, small boilered, worked at low pressure, and of simple and rugged design.[5] Such power with bolted bar frames and cylinders and saddle separately cast imposes minimum demands on manufacturing facilities and requires limited skills of a good part of the mechanical department force,[6] while the relatively small size of power and its high degree of standardization hold down the machinery and stock requirements of running sheds and back shops for maintenance and repair. Power is intensively used and mileage between heavy repairs is not good, which may reflect both the quality of materials used and the character of the work performed. But the entire problem of supplying and maintaining power with limited skilled forces on which to draw is vastly simplified by such a standardization over long periods on power which the West regards as obsolete[7] because of high

[5] Dimensions of all principal types in general use are given in Henry Sampson (ed.), *World Railways,* London, 1952, f.c. 124. See also P. E. Garbutt, *The Russian Railways,* London, 1949, p. 50.

[6] Such frames are bolted together from relatively small rolled bars, while each cylinder may be a separate iron casting and the saddle, cast in one or two pieces, holds the cylinders together and ties them to the frames and the front end of the boiler. By contrast, U.S. practice in the last twenty years of steam locomotive production puts the whole assembly into a single massive steel casting sometimes weighing over a hundred tons.

[7] Between 1938 and 1948 kilometrage between classified repairs for freight power increased from 32,381 to 43,500, while for passenger power it increased from 47,336 to 59,700. The average heavy repair in 1946 required 33.3 days while the average medium repair required 29 days. Heavy classified repairs were shown to include tires, bearings, machinery, cylinders, boiler, and firebox.

fuel consumption, small capacity, inadequate boiler horsepower for sustained high speeds at full tonnage rating, and heavy maintenance cost.[8] Such power is generally hand fired and the common road crew is composed of three men (or women).[9]

While the standard types have been retained, considerable modernization has been accomplished without introducing undue complexity or a very high level of technology. Greater speed, without damage to track, on power having fifty-two-inch and fifty-nine-inch wheels has required the reduction of dynamic augment, which has been accomplished through the introduction of several patterns of disc wheel centers resembling designs used earlier in the United States, while some effort appears to have been expended to lighten rods and valve gear assembly.[10] Coal and water stops have been reduced by the gradual use of larger tenders as well as of condensing tenders in desert country and in areas with bad water. Boiler performance has been improved through the introduction of superheater units comparable to the Elesco Type E and of thermic siphons and exhaust steam injectors on some of the more recent power. Compounding has generally been avoided, while liberal clearances have enabled cylinders and motion work to be kept outside the frames, thus avoiding the maintenance complexities associated with three- and four-cylinder power. No form of articulated[11] power has been in service on more than an experimental basis. Double heading has been preferred to the complexities of large power, although the very flexible Beyer-Garrett has been tried and presumably performed according to its accustomed high standards without, however, commending itself for adoption under the conditions imposed by the Soviet system of maintenance. It is interesting to note that articulation is featured in two recent designs of large steam power, presumably experimental. The articulation is as used in Mallet engines, but the locomotives are not compounded.[12]

[8] This last is largely a reflection of manpower inputs.

[9] By contrast, Soviet freight trains carry no cabooses and a single conductor makes up the rest of the crew.

[10] After 1915, U.S. freight power generally had wheels of sixty-three-inch diameter or larger.

[11] An articulated locomotive is one that employs one or more steam engines coupled to driving wheel sets which are connected to the main frames by pins and are thus permitted to move laterally on curves.

[12] These types show a strong resemblance to U.S. types developed in the late 1930's and built in some number immediately before and during the second war. They are of 2-6-6-2 and 2-8-8-4 wheel arrangements. In view of the shift to diesel now under way, they will presumably not be duplicated.

In the last few years progress has been made in shifting to diesel power in desert country and on some lines of difficult profile,[13] and much more electrification and dieselization is planned under the present seven year plan, so that diesel and electric power will replace steam over the greater part of the system.[14] Whereas a desire to avoid dependence on petroleum fuel has been argued in the past as standing in the way of dieselization, it appears probable that the creation of an adequate maintenance force of the higher and more varied skills required has also stood in the way and is only now being overcome.[15] The advantages of diesel power on lines which permit only a light axle loading and yet have relatively heavy grades are especially great and the adoption of such power may avert the necessity to electrify certain routes where the traffic density appears hardly adequate to support the overhead installations necessary for electrification.[16] On such routes dieselization may produce virtually the same increase in line capacity that could be secured from electrification and it will tend to be done under Soviet conditions less for reasons of operating economy than for increasing the capacity of the line without the necessity of laying additional running track. Nevertheless Soviet analysts place a good deal of emphasis on the prospect of economy and their estimates closely resemble those made in the United States to support the shift to diesel power.[17]

Soviet planning and accomplishment in railway line have shown similar characteristics. Nowhere is there an attempt to promote economic growth through the prior provision of transportation. The idea that settlement and development will follow the construction of a transport system is, as far as possible, reversed. Railroads are looked upon as devices to secure particular objects; hence, whereas the light density of line within Soviet territory as it emerged from the revolution might have suggested a vast expansion to open out new territory,

[13] Profile refers to the combination of gradients over a line of railroad.

[14] The proportion of road freight service worked in steam declined from 89.8 per cent in 1954 to 66.5 per cent in 1959.

[15] The strictures on petroleum fuel appear to have been considerably relieved. An extensive training program to improve the skills of the mechanical force has been required.

[16] Available illustrations and the report of the recent railway mission both indicate, however, that a lighter catenary is used than is acceptable in U.S. practice. Hence the investment requirements per mile of electrified track are presumably lower and the break-even density correspondingly lower. (See *Railway Age,* August 1960, p. 14.)

[17] These analyses have been explored by James H. Blackman and are discussed at some length in his *Transport Development and Locomotive Technology in the Soviet Union,* Columbia, S. C., 1957.

nothing of the sort has occurred. Projects have received careful scrutiny in the light of proposed mineral exploitation, industrial construction, and agricultural development. Maximum use has been made of available waterways in territory not yet penetrated by railroads. Roads and even air transport serve where the volume in immediate prospect does not justify the heavy investment of metals required for minimum standard railroad construction. And this is as would be expected in opening up new territory where the modern variety of means of transport is available, although the calculations employed elsewhere would differ in detail, particularly as to what corresponds to the rate of interest.

The railroad system of Russia, though in considerable part privately developed under the tzars, was never a competitive system. It was planned to meet the more urgent requirements as evaluated by the government in a nonduplicative system and the private portion was developed under a system of concessions somewhat similar to that in France. An integrated network of thin coverage, relatively bereft of feeders except in the mineral districts, resulted. Before the first war roughly two-thirds of the system was owned and operated by the government, and Splawn reports an apparent tendency toward private ownership subsidized and supervised by the government.[18] Notwithstanding the planned character of the system and its lack of duplicative and competitive trackage, its freight traffic density had not quite developed by 1913 to the density of the U.S. network.[19]

The Soviet pattern of development has been wholly intensive, not extensive. Primary attention was placed upon strengthening the more important select main lines of the existing system with a view to concentrating the heavy traffic flows on them. Such routes were given additional second main track, passing sidings, and signal facilities, and were laid with heavier rail on improved roadway; in some instances, grades and curvature on them were ameliorated. Important yard expansion was necessary to permit these lines to operate at something approaching a constant twenty-four-hour tempo, for the presence of traffic that was pressing upon facilities and could be moved without taking account of commercial conditions enabled these lines to handle several times the train density that might congest a similar line in another country, provided the yards were made adequate. The absence

[18] W. M. W. Splawn, *Government Ownership and Operation of Railroads*, New York, 1928, p. 109.

[19] The Russian system carried 940,000 net ton-miles per mile of road compared with 1,190,000 net ton-miles per mile of road in the U.S.

of fast passenger trains was important since it greatly reduced the passes required. Heavier power, four-axle freight car equipment, and cars equipped with air brakes or with air lines were also concentrated on such line segments to permit heavy train loads relative to the system average.[20]

Wherever possible, improvement of existing lines with a minimum of new construction was relied upon to accommodate new and growing industrial areas. Certain cut-offs were constructed to eliminate circuitous movement of important volumes of freight. Other line developments were keyed to economic developments that could be anticipated to produce such volumes of freight traffic as to necessitate railroad connections. Most segments of the existing system became more useful as commodity exchange relationships developed and industrialization progressed. Hence there was a general increase of density, but with a remarkable concentration over the routes planned and developed for heavy traffic movement. As long as congestion of junctions, yards, and terminals is avoided, the favorable effect of this concentration on the efficiency of car movement and car distribution is marked. In appraising results, it must be constantly remembered that between all points there is no competitive routing whatever; that the traffic is normally concentrated over the best-developed direct route; that the volume is sufficient with such concentration of routing to permit early preblocking of trains and often the assembling of trains which can move considerable distances without reclassification (i.e., main trackers); that a shipper's traffic between two points is never distributed over a number of competing routes but instead may be assembled over a period of days, although not loaded into cars, for a multiple-car movement; and that as freight cars comprise a single

[20] The performance of the Soviet system from the re-establishment of the prewar level in 1926 through 1935 when the "transportation crisis" was under way is reminiscent of the Pennsylvania Railroad east of Pittsburgh and Erie during its intensive development from 1900 to 1907, but represents a greater intensification of freight working. The Pennsylvania at the start of the period was, however, probably the most highly developed railroad in the world at the time. The data are:

	Soviet System	Pennsylvania
Increase in first main track	13.5%	6.8%
Increase in ton-miles	275.0%	81.0%

In 1900 when the Pennsylvania's intensive development was about to get under way, its freight density per mile of line was slightly over 3,200,000 net ton-miles per annum, or more than the Soviet density of 1935. When 1907 brought a break in business, the road was equipped to handle higher traffic levels than were actually achieved so far as main trackage and yards were concerned. Pennsylvania's heaviest and standard freight power then was class H-6sb with a tractive effort of 42,500 pounds, some 20 per cent lighter than the standard Soviet power of the thirties.

pool and represent only a slight diversity of types, empties can be distributed without regard to diverse ownerships and types over the most direct routes, thus holding empty car mileage to a minimum.[21] Unhappily the poor mechanical condition of equipment and inadequate inspection at initial terminal too frequently result in the breaking up of maintrackers through the loss of bad-order cars and a filling out of tonnage with other classifications at intermediate points.

Although administrative complexities and deficiencies detract from these advantages, their influence on the operating results must be judged to be very substantial. The key role of yards and terminals in a scheme designed to secure such intensive employment of main trackage explains the vast amount of interest in recent Soviet literature in yard layout and design, yard equipment, and efficient yard operations, and explains also the extensive yard improvement throughout nearly the whole Soviet period.

To economize material, axle loads and speeds have been kept within limits that permit the use of relatively light rail section without an excessive rate of wear, and, as Hunter has pointed out, trains of relatively light weight and moderate speed have been run more frequently.[22] Russian motive power generally does not exceed an axle load of twenty-one tons, the type LK being an exception that is employed in small numbers and only on a limited route mileage. By contrast, heavy American steam freight types generally exceeded thirty-ton axle loading and, in some of the heaviest, exceeded thirty-seven tons.[23] The operation of such heavy power at high speeds, even with large-diameter wheels and good counterbalance, caused severe rail wear and promoted rapid fissure growth even in 132-pound rail section.[24]

Light axle loads and the absence of articulation of course result in locomotives of somewhat limited tractive effort, the heaviest Soviet steam freight power in general use developing 64,790 pounds of

[21] The common use of open-top cars, particularly low-sided gondolas, for commodities which would be loaded in box cars in this country, permits the development of return loads. Planned interchange of bulk commodities commonly loaded in open tops also sometimes facilitates the avoidance of empty car-mileage.

[22] Holland Hunter, "How the Russians Run Railroads," *Railway Age*, August 30, 1954, pp. 24 ff.

[23] In the Pennsylvania Railroad class Q-2, just over thirty-nine tons.

[24] Soviet rail section on Class I lines is generally 91.5 pounds, the interim standard adopted in 1935, but rail up to 131 pounds has been laid. The average main-line track is of less substantial construction and the characteristic slow-speed operation with light power permits low standards for line and surface, hence characteristically rough track. The want of adequate ballasting and drainage, however, necessitates high labor inputs even to maintain these low standards.

tractive effort compared with 72,000 to 156,000 pounds for heavy American steam freight power. The bulk of Soviet freight traffic is handled by power of approximately 53,000 pounds of tractive effort. But where labor is plentiful and train speeds low, the operation of frequent light trains can expedite car movement without noticeable disadvantage up to the point of line congestion. And it must be borne in mind that, apart from track, the greatest investment of steel in the railroad plant is in its car stock so that a saving of cars through faster handling is of particular resource significance. Although the Soviet Union relies heavily upon composite construction in gondola and closed cars, thus avoiding a heavy requirement of plate by substituting wood sheathing, the principal weight of steel is in car trucks and underframe and cannot be dispensed with.[25] It is from this heavy steel requirement and the accompanying necessity to expand heavy casting, rolling, and forging facilities that the extreme pressures to economize the use of freight cars apparently derive. As will appear, the Soviet railroads and the ministry have deceived themselves and the public, for their active fleet of freight cars is not as small as represented by their data and in consequence the car turnaround is not as fast as reported. In addition, there are important exclusions from the active fleet. Nevertheless performance measured by this datum is excellent when judged by Western standards of experience.

Soviet Use of Plant and Equipment

INTENSIVE UTILIZATION

There are four principal categories of plant and equipment employed together in a railroad operation: permanent way, yards and terminals, motive power, and cars. To these must be added the facilities necessary for inspection, servicing, and running repair. Soviet practice is generally designed to make intensive use of all elements of plant and equipment and has been under continual pressure to handle burgeoning traffic and to hold investment to a minimum. To meet effectively the requirements made of it by the traffic, any railroad operation must achieve a balance among the elements of plant and equipment, but that balance may differ from one railroad to another depending upon the needs of the service. At any time the proportions of the plant relative to the traffic load may bring alterations in the manner of its working.

[25] Car trucks fabricated out of bars continue in use, however, although completely replaced with cast steel side frames in the United States.

The available Soviet operating statistics are less complete than those of the United States, although they include some items which are unknown here, but they do comprise data from which important operating averages can be computed and they enable a general impression of the operation to be secured. For our purpose, which is to confirm the possibility of achieving the recorded traffic performance with the available plant and thus gain assurance of the usefulness of the traffic data as an indication of economic growth, they are reasonably adequate. Nonetheless, it will be necessary to resort to speculation in reviewing these data in order to judge their meaning. And, as noted in Chapter 2, great caution should be observed with the operating statistics given in Appendix A on which we shall have to rely. A variety of methods has been employed in calculating certain approximations in the basic series on varying but often scant evidence and on occasion interpolation has been resorted to in order to chart what appears to have been the probable course of events. Always it should be borne in mind that the quality of service rendered by the Soviet railways differs substantially from that in Western countries and when comparisons are made with U.S. performance it should be noted that our railroads perform a substantial storage function and certain marketing service functions that are not regarded as within the realm of transport in the Soviet Union.

PERMANENT WAY

The relatively high freight traffic density per mile of line recorded in the late 1930's for the Soviet system aroused some skepticism.[26] What, then, must be said of a density which appears to have stood in 1954 at 59 per cent above the prewar peak of 1939? If comparison is made with average freight densities in other parts of the world, the Soviet performance appears improbable; but it is characteristic of most Western systems, and of the U.S. railways in particular, that they have much greater mileage of a character that seldom exists in the Soviet system and that, where they have been developed on a competitive plan as in North America or Great Britain, there is much duplication of main lines and considerable overbuilding. Nor has any large railroad system elsewhere so nearly made maximum use

[26] It is to be recalled, however, that, as pointed out in Chapter 2, Soviet tonnage originated is most certainly overstated and, as appears in Chapter 3, the overstatement is probably greatest for some of the long-haul commodities moving in closed cars. This may produce a greater overstatement of ton-kilometers than of tonnage. In any event traffic density when measured in ton-kilometers per kilometer of line is overstated in consequence.

of main-line trackage by not operating exceptionally high-speed trains and by avoiding the bunching of trains at particular hours according to the needs of traffic and in disregard of the commercial convenience that carries much weight in a competitive system. As Sir William Acworth puts it, "no one needs to be told that the running of trains at varying rates of speed diminishes enormously the carrying capacity of a line."[27] Nor need one doubt that extensive multiple tracking and improvement of signaling have been forced in the United States, not by the amount of traffic to be dealt with in twenty-four hours, but by the bunching of a good part of the day's traffic over certain sections of the line in a limited span of hours. This happened because of the necessity to schedule arrivals and departures of freight as well as passenger trains to meet the public convenience under pain of losing the business to a more accommodating competitor.

Operating statistics on a uniform and comprehensive basis began to be compiled for the U.S. railways during the first war under the aegis of the U.S. Railroad Administration. Reverting to the returns of 1923, when the postwar depression and the shopmen's strike had been overcome, we may indulge in a few comparisons with a period when the American lines operated almost wholly on steam power[28] (much of which was roughly comparable in tractive effort to the heaviest of Soviet motive power) at roughly comparable freight train speeds and without the especially fast long-distance freight and passenger trains of more recent years.[29] In November of 1923 the average density (net ton-miles per mile of road per day) for large steam railroads (excluding the Long Island) ranged from 2,289 for the Denver and Rio Grande Western to 30,872 for the Pittsburgh and Lake Erie.[30] If the November density were multiplied by twelve, bearing in mind the tendency for growth to obscure seasonal variance in the Soviet case, and employing November in preference to the October peak month, we would obtain the following comparisons:

Net Ton-Kilometers per Kilometer of Line per Year			*Net Ton-Miles per Mile of Line per Year*	
Soviet system	1939	4,570,000	Pennsylvania RR	4,659,955
	1954	7,134,000	Pittsburgh and Lake Erie RR	11,268,280
	1958	10,672,000	Erie Railroad	5,322,065

[27] William Acworth, *The Railways of England*, London, 1899, p. 399.

[28] A small electrified freight service existed on the New Haven, Norfolk and Western, Virginian, and Milwaukee. Diesel power was as yet unknown.

[29] It should not be supposed that even in 1923 the quality of American passenger trains in speed was as poor as that of the Soviet system today.

[30] The respective October figures were 2,613 and 36,419. (Interstate Commerce Commission, *Operating Statistics of Large Steam Railroads*, October and November 1923.)

In November 1923, 20,538 miles (roughly one-seventh) of the United States system had densities exceeding those of the Soviet system in 1939, but no large railroad had exceeded the density which the Soviet system achieved by 1954, since the Pittsburgh and Lake Erie was a property operating only 231 miles of road, almost all of which was mutiple-track line.

Our knowledge of the mileage of second and additional main track for the Soviet Union does not extend beyond the late 1930's, except for a few benchmark years. That there has been a good bit of multiple tracking since the war may be inferred from the intensive growth of other elements of plant, and the references to such work in the literature. However, it is impossible to put it into quantitative terms although the 1950 Plan, if realized, would have resulted in about 30 per cent of the system being double tracked. The closeness of the Soviet and Pennsylvania Railroad freight densities shown above suggests a comparison of the trackage position of the two for the respective years.[31] The Pennsylvania System in 1923 had a second main track over approximately one-third of its length, a third track on approximately 8 per cent of its road mileage, and a fourth track on about 6 per cent of the road.[32] In 1938 the Soviet system had a second track over 30 per cent of its road mileage, but we have no definite information about third and additional main running track.[33] Portions of the double track on the Pennsylvania could be accounted as necessary only because of bunched fast passenger schedules and the same was true of portions of its third and fourth track mileage. The position as to main running track was, therefore, roughly comparable. The range of densities on the Pennsylvania main trackage appears, however, to have been much wider than that of the Soviet system, for it had secondary lines of very light traffic as well as densities upon the New York, Philadelphia, Middle, and Pittsburgh Division main lines which never were approached by any portion of the Soviet railroad system.

The year 1952 gives the highest traffic performance of recent years for many of our large railroad systems. In November of that year the traffic density, converted to an annual rate, for 8,723 miles of line in the United States embracing seven separate reporting railroad systems, exceeded the density of the Soviet system. These densities ranged up to 12,960,785 net ton-miles for the Bessemer and Lake Erie, slightly

[31] It should be borne in mind that the passenger traffic density of the Pennsylvania System was in 1923 about one-half that of the Soviet system in 1939.

[32] From the Record of Transportation Lines as quoted in *Poor's, Railroad Section.*

[33] Holland Hunter, *Soviet Transportation Policy*, Cambridge, Mass., 1957, p. 371.

more than one-half of which was double tracked. On 12,072 additional miles of line the U.S. densities exceeded 6 million ton-miles, hence closely approached the Soviet average. It is of particular interest that the New York, Chicago, and St. Louis Railway Co. (almost entirely single track) achieved a hypothetical[34] density of approximately 6 million net ton-miles per mile of road. Other high-density roads which were almost entirely single-track systems were:[35]

Southern Pacific	8,065 miles of line	4,205,895 net ton-miles per mile of road
Western Pacific	1,190 miles of line	3,978,500 net ton-miles per mile of road

Track capacity, of course, is more nearly related to the number of train movements per twenty-four hours than to the ton-mileage put over it. The Soviet system has traditionally run frequent comparatively light freight trains, although average freight trainloads have shown a fairly continual increase. Over the average kilometer of main line, the Soviet system put 6,534 freight train-kilometers in 1939.[36] At the November rate, the Pennsylvania system operated 5,306 freight train-miles per mile of road in 1923. The year 1958 is the last for which we have Soviet data, partly estimated, covering road mileage, average locomotive-kilometers per locomotive day and average number of freight locomotives in service. These data give 9,510 freight train-kilometers per kilometer of road. By comparison, the Cincinnati, New Orleans, and Texas Pacific (roughly two-thirds double track and the remainder single) operated 7,536 freight train-miles per mile of road in 1952, the single-track New York, Chicago, and St. Louis operated 4,164, and the Pennsylvania System as a whole operated 3,490.[37] On the Middle Division the Pennsylvania, during heavy traffic months, has often in the prediesel period exceeded the rate of 28,000 freight train-miles per mile of road per annum handled primarily on the two freight tracks, as the passenger mains were required to accommodate upward of sixty passenger trains per day. A similar rate has been achieved on the double-track line between Wago and Columbia, while over the heavy grades via Gallitzin Summit the movement has often exceeded 100 freight trains per day, for the most part accommodated on the two freight running tracks,[38] despite

[34] That is, twelve times the November figure.

[35] Densities from *Operating Statistics of Large Steam Railroads,* Interstate Commerce Commission, November 1952. Track mileage from *Sixty-sixth Annual Report on the Statistics of Railways in the United States,* Interstate Commerce Commission, 1952.

[36] Computed from series C-22 and C-34 in Appendix C.

[37] *Statistics of Railways in the United States,* Interstate Commerce Commission, 1952.

[38] See Pennsylvania Railroad Company, *Traffic Density Charts by Divisions.*

the necessity for return of large numbers of light engines in helper service. There appears to be no reason to question the practicability, in the light of our experience, of the ton-kilometer or freight train densities reported in the Soviet statistics. The performance is clearly possible upon a road mileage with the proportion of second track indicated under the operating conditions which prevail in the Soviet Union.[39]

YARD AND TERMINAL FACILITIES

No large body of information on Soviet yard and terminal practice has come to our attention, nor has a special effort been made to study this phase of Soviet railroad operations. It is, however, apparent that considerable emphasis has been placed on yard improvements, the analysis of yard operations, and the training of yard and terminal personnel. A considerable analytical and instructional literature, which has no recent parallel in the English language, has appeared but is generally devoid of data on actual yard performance. Large retarder-equipped yards appear to be increasing in number at strategic points where it is possible to concentrate car classification, and added emphasis has been accorded this phase of plant improvement since the war.

On January 1, 1946, there were reported to be 896 division and classification yards on the Soviet rail system, giving an average spacing not exceeding 125.97 kilometers.[40] Since Soviet road freight power is customarily assigned to an engine house and operates out and back with an assigned crew, division points tend to be placed at convenient points for an engine turn. Such divisional yards, in many instances, appear to perform little more work than change of engines and crews, inspection, cutting out of bad-order cars, and adjustment of tonnage. At major classification yards, considerable traffic is often relayed through without the trains being worked, although the cars included in such trains are reported in the count of cars handled. Cars are shown, on the average, to have been detained 6.5 hours in 1940 and 8.0 hours in 1945 in each yard along the route and the total number of such detentions encountered at yards transited in each full car turnaround was 10.7 in 1940 (one each 96.4 kilometers) and 13.2 in

[39] It must also be recalled that, as Khachaturov points out, the bulk of the Soviet system is of easy profile and with moderate curvature (see S. S. Balzak, *et al., Economic Geography of the USSR*, New York, 1949, p. 449).

[40] D. P. Zagliadimov, *et al., Organizatsiia dvizheniia na zheleznodorozhnom transporte* [Organization of Movement of Railroad Transportation], Moscow, 1947, p. 384. When allowance is made for duplication at junctions, the average spacing is somewhat shorter.

1945 (one each 99.7 kilometers).[41] Detention at major intermediate yards has been steadily reduced as an element in the turnaround of the average car, having declined from 73.7 hours per turnaround in 1950 to 50.0 hours in 1958.[42] The relatively modest detention, by comparison with averages experienced in representative major U.S. yards, would appear to reflect in part the frequent movement in small trainload lots and the absence of extensive branch line and local service and in part the extent of forwarding in full train lots and effective prior classification.

Much has been made in the Soviet literature of the practice of forwarding in solid trainloads from origin points to final destination and continuing emphasis is given to the potential importance of this practice in improving the efficiency of railroad operations. Yet definitive information is conspicuous by its absence. It has been asserted that from 40 to 70 per cent of the total tons originated moves in full trainload lots, but such a statement provides wide margin for speculation.[43] Moreover, it is confirmed only to a limited extent by some other data, notably those on the percentages of coal cars switched at yards in the Donets Basin traffic where one would expect to find opportunities for the forwarding of traffic in solid trains. Traffic planning on a monthly basis does provide for the accumulation of quantities to be shipped between particular installations in order to offer the traffic in multiple-car lots and it provides for the exchange of orders among suppliers to the same end. Certain customary solid train movements are known to exist in the coal, ore, petroleum, and timber trades. As the trainload is smaller and less variable than in U.S. practice and as an effort, lacking in the Western countries, is made to encourage multiple-car movements, it may be concluded that the practice has its effect upon the volume of yard work which must be performed.[44]

Effective prior classification, as distinct from movement in full trains, probably has a greater influence in holding down the volume of switching at intermediate points. The control of traffic by the railroads, the absence of diversity of routing, and the simplicity of the network

[41] *Ibid.*, p. 384.

[42] L. S. Iakubov, *Osnovy zheleznodorozhnoi statistiki* [Principles of Railroad Statistics], 2nd ed., Moscow, 1959.

[43] Tretiakov, *et al.*, *Ocherki razvitiia zheleznodorozhnoi nauki i tekhniki* [Essays on the Development of Railroad Science and Technology], Moscow, 1953, p. 236.

[44] As already noted, however, laudable efforts at origin terminals appear frequently to be frustrated by poor mechanical condition of equipment, inadequate maintenance, and indifferent inspection and servicing.

all contribute to the feasibility of putting cars at or near initial terminals into trains which may be handled without intermediate switching to or near final destination.[45] The only comprehensive and detailed study of car movement on the railways of the United States was made in 1933. A comparison with 1940 Soviet data on yard and terminal delay is shown in Table 17, but it should be noted that the U.S. data, derived from terminated waybills, refer to loaded cars only, while the Soviet data include complete turnaround from one loading to the next. The average Soviet car was yarded less frequently in

TABLE 17

COMPARISON OF ELEMENTS OF TURNAROUND: UNITED STATES, 1933, AND SOVIET UNION, 1940

	United States[1]	Soviet Union[2]
Average haul (miles)	353	823
Miles between yardings	46.7	76.9
Detention at yards and terminals (hours)	53	69.6
Average detention per yard or terminal (hours)	7.3	6.5

SOURCE: Col. 1: *Freight Traffic Report*, 1935, Vol. II, pp. 264 ff; col. 2: Zagliadimov, *Organizatsiia dvizheniia*, p. 384.

comparison with the mileage made. In the light of the different conditions encountered by the Soviet railroads, the difference in average detention does not appear to have been significant. But the effect of fewer yardings in a unified and noncompetitive system is to hold down total detention per car turnaround.[46]

In fixing norms and in pressing for their fulfillment, the Soviet administration emphasizes both an increase in the average trainload and a decrease in the average detention at yards and terminals. If other conditions remain the same, these are opposed objectives and tend to obstruct one another. Unless the volume of traffic for each destination separated in the classification yard increases proportionally with the increase in average net trainload, the improved train loading will be achieved at the cost of increased car detention. If density of

[45] On the inefficiencies which may thus be reduced, see John R. Turney, "The Price of Open Gateways," *Annals of the American Academy of Political and Social Science*, September 1936, p. 22.

[46] It should be noted that evidence appears from time to time that reported average detention is minimized by inflating the car count. It is not known how widespread this practice is, but the incentives for such manipulation are considerable in the effort of yard supervisors to meet their norms. In the United States the methods of determining car count are not always uniform from yard to yard even on the same railroad, but reliance is most commonly placed upon cars dispatched as a method for measuring performance.

traffic, profile, and characteristics of motive power are kept in mind, it would appear that efforts to minimize yard detention have outweighed efforts to improve trainload. However, the immediate postwar increase in average detention may in part reflect improved train loading, although it is much more likely to reflect less effective multiple-car consignments, less complete prior blocking of trains, some degree of general disorganization of traffic movement, and less satisfactory condition of equipment. Computed or reported car turnaround in recent years, taken in conjunction with the average haul, implies great success in reverting to earlier levels of yard detention. It would appear that over most of the Soviet period yard facilities have been kept at a reasonable level of adequacy, save for the period of the early thirties when some evidence of congestion appears as noted in Chapter 2 above.[47]

MOTIVE POWER UTILIZATION

Data on the Soviet locomotive stock, both in total and in composition, as well as on its condition (serviceable, unserviceable, and stored), is so incomplete and conjectural since 1940 as to make it hazardous to undertake an analysis of the efficiency with which the stock is employed. What can be said is almost wholly confined to the stock of road freight locomotives. Nothing of moment is known about the utilization of switching power and little about the use obtained from passenger power. Reference to the notes to the appendix tables on locomotive stock will make apparent the extent to which it has been necessary to resort to estimates computed from operating data, i.e., locomotive-miles derived from train-miles and then divided by average locomotive-miles per locomotive-day to give an approximation of active road freight locomotives. A further difficulty is presented by certain known shifts in the method of reporting and the possibility that other undetected shifts have occurred. Nevertheless some discussion may be useful if its highly provisional character is borne in mind.

As a measure of the intensity of use, locomotive-miles per locomotive-day is commonly employed and, when average train speed is taken into account, this can be converted appropriately into the hours spent on the road by the average locomotive. Comparisons have occasionally been made between these data as reported by United States and by

[47] Like main trackage, yard facilities are no doubt objects of very intensive use. A relatively constant flow of traffic contributes to this end but, at the cost of increased switching engine and yard crew hours, relatively small facilities can be employed to transit a heavy flow of traffic, as differences among American yards abundantly demonstrate.

Soviet railroads—both of which employ a statistic carrying in effect the same title. There is, however, an important difference in coverage and it is impossible to adjust the U.S. statistic to make it completely comparable with the Soviet one. The U.S. datum is computed monthly by multiplying average locomotives (serviceable *and* unserviceable, but not including stored) on line by the days in the month and dividing this product into total locomotive-miles—principal, helper, and light. In the Soviet case, unserviceable locomotives are excluded from the working fleet as well as stored or reserve locomotives, and the excluded unserviceables were adjusted after 1932 to include locomotives awaiting or undergoing boiler wash. A more important difference, however, is that operating averages are computed from actual locomotive-hours in the class of service reported, these data being secured from engine house registers at maintaining engine houses. Hence the statistics are different in kind, and one should expect locomotive-kilometers per locomotive-day in the USSR to be substantially higher than in the United States. Some notion of comparative intensity of use can, however, be secured from comparison of locomotive-miles per active locomotive-day as well as by another approach. Thus an impression of the plausibility of the reported Soviet performance can be formed which makes it possible to judge whether the locomotive fleet, reported for some years and estimated for others, is likely to be adequate to move the traffic shown in the Soviet data. No refined techniques are appropriate to the crude data with which it is necessary to work.

Converted roughly into mileage, the recorded Soviet data for average daily miles per locomotive in road freight service are as follows for selected years:[48]

1930	93	1950	157
1935	118	1951	161
1940	159	1952	165
1945	138	1953	169
1949	145	1954	170

For comparison, certain select railroads in the United States are shown in Table 18 below for various years during the steam era. The roads represent a variety of conditions and the data are for the October peaks of years of heavy traffic. The data for 1922 reflect the shortage of power produced by the shopmen's strike of that year and are generally higher than the adjacent years. The mileages shown have been cal-

[48] See series C-25 in Appendix C for original and estimated data and explanatory notes.

TABLE 18

U.S. LOCOMOTIVE PERFORMANCE, SELECTED YEARS

	Locomotive-Miles per Locomotive-Day			Average Train Speed, 1944 (miles per hour)	Daily Hours on Road, 1944
	1922	1929	1944		
New York Central	92.2	89.1	121.3	15.5	7.8
Pennsylvania	77.6	75.3	98.9	13.4	7.4
Santa Fe	103.1	111.3	154.9	17.5	8.8
Illinois Central	96.0	95.5	85.3	15.4	5.5
Union Pacific	126.1	141.5	149.2	18.5	8.1
New York, Chicago, and St. Louis			148.3	18.7	7.9

SOURCE: *Operating Statistics of Large Steam Railroads,* October 1922, 1929, and 1944, I.C.C.

culated from the operating statistics and represent locomotive-miles per active locomotive-day (i.e., all locomotives not reported as either stored or unserviceable are counted as active). The 1944 data illustrate what could be accomplished under the heavy traffic pressure of a peak war year and generally give the best results achieved in steam by American railroads.

As the Soviet data compute locomotive-days from the time of locomotives in road freight service, they exclude waiting time beyond twenty-four hours at the dispatching engine house which is included in the locomotive-days from which the American data are calculated. Moreover, pusher locomotives and locomotives in way freight and transfer service are excluded from the Soviet data, these types of service being some in which low daily mileage is normally secured. The Soviet daily mileage is, therefore, to be associated with a larger number of daily hours on the road for the average locomotive. This in turn results from the less inclusive locomotive population employed in the calculation. No comparable American statistic is available as locomotives are handled and reported in a different way in this country.

Soviet statistical instructions call for the systematic passage into depot reserves of locomotives idle more than twenty-four hours and for the transfer to railroad reserves of locomotives idle more than ten days. These locomotives are excluded from the working fleet as are those in process of transfer from one maintaining engine house to another. An effort is apparently made to use locomotive-miles per locomotive-day as a measure of the performance of the operating department; hence care is taken to avoid charging to the locomotive

time which instead should be charged to the mechanical department or to a fluctuation in traffic volume.[49]

We may conclude: (1) that there is a difference of definition in the Soviet and American statistics in the face of which we should expect to find the average serviceable Soviet locomotive, not stored or in transfer, to be in use more hours per day than its American counterpart; and (2) that the conditions of Soviet rail operations, particularly the greater freight train density and the lack of daily, weekly, and seasonal fluctuations of the sort familiar to Western countries, permit somewhat greater actual useful hours on the road per serviceable locomotive-day. We are unable to assign weights to these two factors. The higher apparent mileage per locomotive-day is a result of both these factors and need not be regarded as exceptional, much less impossible to attain. We may further conclude that the maintenance of a favorable statistical showing from year to year is in part achieved by manipulation of the road freight locomotive component of the working fleet and that the uniformity in ratio between hours on the road and hours consumed in a full turn (i.e., in the fraction of a day that is spent on the road by the average locomotive) leaves open to suspicion the data which purport to reflect intensity of use.

Composite passenger-ton-kilometers, a representation of total line-haul output obtained by adding passenger-kilometers and ton-kilometers,[50] increased 664 per cent between 1928 and 1953.[51] During the same period the aggregate tractive effort of the inventory fleet of locomotives increased by 196 per cent,[52] while the number of locomotives in the inventory fleet increased 106 per cent.[53] Obviously there has been a remarkable intensification in motive power use if these data are even remotely accurate, despite the fact that self-propelled electric multiple-unit trains have accounted for much of the increase in passenger-miles.

In the United States since 1929 there has been a decline both in the number of locomotive units and in the aggregate tractive effort. The period since 1945 has been marked by rapid dieselization and, as tractive effort provides a much less reliable measure of the capacity

[49] Careful instructions for the proper assignment of a day's locomotive time between operating and mechanical departments and the reserves are given in Iakubov, *Osnovy zhelez. statistiki*, pp. 168 ff.

[50] Common U.S. practice is to treat each passenger-kilometer as the equivalent of two ton-kilometers, although some studies employ the ratio of average passenger-mile revenues to average ton-mile revenues.

[51] See series C-38.

[52] See series C-24.

[53] See series C-23.

of diesel than of steam power, comparison of years since that date with earlier years becomes less useful as the share of diesel power increases. As U.S. railroads now perform virtually 100 per cent of their work with diesel or electric power, direct comparisons of U.S. and Soviet locomotive performance for the last five or six years are not feasible. Certain comparisons up to 1947 will, however, give a rough idea of the relationship of power to line-haul traffic in the two countries and are given in Table 19. When it is borne in mind that a proper com-

TABLE 19

LOCOMOTIVE PERFORMANCE, UNITED STATES AND SOVIET UNION, SELECTED YEARS

	Traffic Units (billion ton-kms. plus billion passenger-kms.)		*Aggregate Tractive Effort (metric tons)*		*Traffic Units per Ton of Tractive Effort*	
	U.S.	USSR	U.S.	USSR	U.S.	USSR
1929	765	145	1,176,800	192,600	63,817	75,285
1938	499	476	986,090	355,400	50,604	133,933
1944	1,332	n.a.	1,053,200	n.a.	126,567	n.a.
1946	1,043	467	1,047,200	425,000a	99,599	109,882
1947	1,099	476	1,040,000	440,000a	105,673	108,180
1953	n.c.	900	n.c.	551,000	n. c.	163,340

SOURCE: For U.S., underlying data from *Statistics of Railways in the United States* of each year, I.C.C.; for USSR, series C-38 and C-24 in Appendix C.

a Estimated.

n.c.=not comparable.

parison would be in gross ton-miles which, in the Soviet data, would be too far removed from statistics in which we can have some confidence, these comparisons indicate the possibility that the Soviet roads have achieved approximately the performance claimed.[54] The data for the two countries should be somewhat closer together in gross-ton-miles, since the ratio of tare to total weight is higher in the United States as a result of the higher percentage of empty car movement and lighter average carload in proportion to light weight of cars. When, in addition, allowance is made for the slower Soviet speeds in both freight and passenger service, the light passenger trainload characteristic of United States operations and the heavier average weight per revenue seat provided, the relatively larger amount of switching work and of light-traffic branch-line service to be performed in the United States, and other factors, even the very high Soviet figure for 1953 loses most of its improbability. U.S. motive power was under greatest pressure in 1944, but even then it is doubtful whether important parts of it

[54] Here it should be remembered that the ton-kilometers employed for computing the Soviet relationship are undoubtedly overstated.

were, in the light of traffic conditions, capable of being usefully employed for as great a part of the average day as is feasible under Soviet conditions, while there was some loss of potential capacity as a result of crew shortage. It must also be recalled that the use of locomotives in American practice is restrained by working agreements with the operating unions which have no counterpart in Soviet practice. The conditions of these agreements in particular occasion the assignment of more switching power than would otherwise be necessary and were not modified even in wartime.

Despite all differences, certain American roads have equaled or exceeded the reported Soviet 1953 performance during years of pressure. This applies notably to the Santa Fe Road, which in 1943 and 1944 recorded approximately 163,000 traffic units per ton of aggregate tractive effort, and to the Union Pacific, which exceeded 173,000 in the same years. The Southern Pacific was not far behind. These and other roads now have a higher level of performance, but as it is achieved almost entirely with diesel power, it cannot be assigned significance in testing Soviet performance, which has been primarily in steam. All three of them, however, operate under more difficult profile conditions than the Soviet system, and even in the war years they endeavored to maintain a superlatively fast passenger and manifest freight service while also handling a large number of special military moves. The three taken together accounted for approximately 12 per cent of the 1944 traffic units of American railways. By way of contrast, the Pennsylvania, which handles more than 10 per cent of the traffic units, with its heavy passenger business, vast local freight business, and relatively short hauls, achieved only 109,000 traffic units per ton of tractive effort in 1944.

FREIGHT CAR EQUIPMENT

A great deal of attention has been focused on the rapid turnaround reported to be achieved by the Soviet freight car stock. When due consideration is accorded the long average haul, it does not immediately appear plausible. The Russian railroads before World War I had a turnaround which, considering the short average haul and the small capacity equipment employed, compared unfavorably with Western Europe and North America.[55] During the late war years and the revolutionary period, conditions appear to have worsened materially and prewar turnaround was not approached again until

[55] For turnaround data, see series C-29.

1925/26. Thereafter a steady decline continued until the early 1930's when the level fluctuated around 9.5 days. Under the pressure of the "transportation crisis," this datum was forced down to 6.78 days in 1936 and thereafter was generally somewhat higher until, during the war period, it advanced to substantially higher levels, attaining an apparent maximum of 13.8 days in 1942. The postwar period has been characterized by a rapid decline to 6.23 days in 1955 and 5.72 days in 1959, the last year for which a report is available. By contrast to these rapid reported car turnarounds for the Soviet system, U.S. railroads have only twice recorded a turnaround of less than fourteen days and in the last few years have encountered turnarounds exceeding fifteen days. Attention has already been called to the longer average hauls prevailing in the Soviet Union, as well as to certain other factors affecting car turnaround. It is necessary to undertake here a more systematic appraisal.

The concepts employed in the two countries are similar but not necessarily the same.[56] Both relate the stock of serviceable cars on line to the cars loaded. The Soviets appear to exclude inactive and light repair cars, however, both of which are included in the United States turnaround as ordinarily computed. Car turnaround is thus a calculated datum whose accuracy depends upon the accuracy of the record of cars on line and of the reporting of cars loaded. In neither country are actual serviceable car-days available, the size of the stock being taken at a given date (reported on the first and fifteenth of the month in United States practice) and applied to the carloadings of a more extended period. Car turnaround differs, of course, not only from year to year, but from month to month. Thus in United States practice, car turnaround reaches its minimum ordinarily in the October peak weeks. The best reported performances for the four highest consecutive weeks calculated from October 1 serviceable cars on line less minimum surpluses appear to have been those of October 1929 and October 1939 at 11.7 and 11.3 days respectively.[57] The 1939 turnaround was exceeded in every year of World War II and, under the influence of the five-day week and other changed conditions, turnaround has assumed a generally higher level in more recent peak periods.

[56] Active, serviceable, or "working" car stock divided by carloadings. Thus the ratio is intended to give elapsed time from one loading to another.

[57] Calculated by the Association of American Railroads and reported to the Office of Defense Mobilization for use of the "Conway" Committee on rolling stock requirements.

Whereas the accuracy of U.S. data for serviceable cars on line can be accepted, the reported surplus is normally understated and tends to vary in accuracy with the supply of and demand for cars. Hence any calculation which seeks comparability with the Soviet concept by employing active cars to compute turnaround tends to overstate United States car turnaround. On the other hand, Soviet records of cars in existence and on line are loose and would appear to be easily subject to manipulation. Our conclusion is that the number of active cars on line, the "working fleet," is understated and that the percentage of understatement varies from time to time and is related to the contemporaneous pressures for a good statistical showing. In short, the figure is manipulated. It appears impossible to develop any measure of the understatement, but the existence of a bias contrary to that of the U.S. data should continually be borne in mind. Nor can the possibility of accretion in the percentage of understatement of the Soviet "working fleet" be discounted completely. An understatement of 10 per cent in the "working fleet," which is far from improbable, would increase a reported turnaround of seven days to 7.8 days. We have no basis for suggesting that the understatement is of this order of magnitude, however, and it could exceed this level.

This is a matter of considerable importance, for it indicates a larger investment in rolling stock than we are led to expect by the published data purporting to show the ownership of freight cars. Moreover, since it means an understatement of car turnaround, confidence that this equipment is understated can diminish our suspicion of the ability of carriers to handle the reported traffic as represented by carloadings.[58] It is desirable, therefore, to review the evidence that leads us to this conclusion.[59] This necessitates some discussion of our understanding of Soviet car accounting for, more than anything else, the looseness in the system of car accounting leads us to expect substantial understatement, and we find this conclusion reinforced in those years for which a check of in and out movement in the fleet with the reported inventory has been possible.[60] It appears that the Soviet statistics of cars available to the railroad service (inventory fleet) rest not on what is in effect a perpetual inventory, as on American railroads, but on physical inventories taken each year with a resulting adjustment of

[58] Our appraisal of ton-kilometrage appears in Chapter 2.

[59] Disparity between growth of the inventory and working fleets and the data upon cars built and retired has been noted in Chapter 2 and is discussed at greater length in Appendix A.

[60] The discussion here, of course, refers to car turnaround computed by dividing the working fleet by average daily carloadings.

the account when particular car numbers fail to appear in the inventory for a prescribed number of consecutive years.[61] Additions to the fleet are not necessarily recorded except as they are picked up through the count, while cars actually in existence and hitherto recorded may be dropped as a result of their failure to be picked up in the count. Moreover, the portion of this stock attributed to the working fleet is subject to manipulation by transfers to bad order, to reserve, to other ministries by lease, to railroad construction, to use for company material and other railroad service, and to the Ministry fleet, among other possibilities.[62] The absence of per diem settlement between the several railroads making up the system leaves a gap in the statistics of car movement and car location because of the failure of car interchange reports to reflect accurately the movement.

To ascertain car stock by a physical count of cars on the line is a method which at best leads to understatement. Cars at outlying sidings and nonagency points are likely to escape the count. Even in yards and in large industrial districts cars are likely to be ignored. On American railroads many instances come to light of serviceable cars which have been allowed to stand idle from failure of notice for extended periods of time sometimes exceeding a year. Such cars have not been reported to the car distributor as available for loading. Many more such instances undoubtedly exist than reach the attention of the supervisors and car service agents of the Association of American Railroads and of the Interstate Commerce Commission. But such cars on an American road are included in the serviceables reported on line and enter the calculation of car turnaround, for the car record office, quite independently of the 7 A.M. or other counts, maintains a perpetual inventory adjusted by installations, retirements, cars delivered to connections, and cars received from connections, which is reduced only by the count of cars reported surplus and in bad order when computing car turnaround.[63] Under the American system there is no incentive actually to fail to detect the existence of serviceable cars, although yardmasters and agents may be tempted to hold

[61] At inventory, or "census," time an effort is apparently made to hold railroad operations to a minimum until the census can be completed. Detailed instructions issued for the taking of the census appear designed to secure as much accuracy as possible.

[62] It is also unclear whether cars which pass onto trackage of other ministries in connection with industrial switching, loading, and unloading operations are included in the working fleet.

[63] Bad-order cars are, however, subject to manipulation—usually to understatement where pressure is exerted to increase the serviceable fleet. Such understatement necessarily increases car turnaround.

It is necessary, if car turnaround is to be understood, to obtain some conception of its composition, that is, to account for the time of the car spent in the various activities between one loading and the next. Soviet students have from time to time undertaken analyses—indeed a good bit of attention has been concentrated on the subject. Less study has been accorded it elsewhere in the world and only one effort has been made in the United States to secure an actual record of the history of the movement of a large number of cars under load—that of the Federal Coordinator who did not, however, study the complete car turnaround. The adoption of machine methods is now leading some U.S. railroads to study the movement of cars on their own lines. For the present, however, we must work with a paucity of material. Table 20 sets out two calculations of turnaround on U.S. railroads made at widely separated times, but the later one is based on the method and on some of the assumptions of the earlier one, together with a breakdown of Soviet car turnaround at several different times, given in days. Except for much heavier proportions of less-than-carload freight than has ever characterized Soviet rail operation, the U.S. performance of 1910 probably comes the closest to Soviet conditions. That of 1954 departs so far from conditions in the Soviet Union as to afford an unsatisfactory basis for comparison. Undoubtedly, the turnaround in peak months was somewhat less than that shown in Loree's 1910 analysis, but we may nevertheless proceed to some comparisons which accept his estimates as a point of departure and employ the Soviet 1940 data as representative, although not the lowest on record.

The differences in the line-haul portion of the account result from a U.S. turnaround trip (loaded plus empty) in 1910 of 571 kilometers compared with a Soviet turnaround in 1940 of 1,032 kilometers, while the U.S. road speed in that year was 16 kilometers compared with 20.3 kilometers for the USSR in 1940. The average U.S. car is assumed to have encountered 5.4 intermediate yardings and interchanges on this average haul; the Soviet car, approximately 10 intermediate yardings over its longer haul. Zagliadimov reports an average delay of 6.5 hours per intermediate yarding, while the Loree estimate supposes 17.9 hours for the U.S. average intermediate yarding or interchange. Neither the Soviet nor the Loree estimates represent an actual accounting for elapsed car time between receipt and dispatch. Interchange between U.S. roads frequently involves a double yarding plus the loss of time on interchange tracks. Thus the U.S. yardings should be increased by 3.6 to obtain greater comparability, resulting

cars to protect loading in their own territory and thus fail to report them as surplus to the car distributor. Under the Soviet system, however, a premium is placed upon failure to report the existence and location of cars because of the emphasis on operating norms which derive from the size of the car stock. The presence of underreporting is appreciated and is frequently commented upon with examples that have been discovered in the Soviet railroad press. Hence a system which would in any event tend to understatement would appear to become a worse instrument as a result of the stimulus to increase the downward bias by nonreporting. Moreover, cars accumulated for seasonal loading are specifically excluded from the working fleet. No confidence can be developed in the significance of data developed within such a system nor can any precise interpretation of freight car turnaround be developed in consequence.

Because of the importance attached to the intensive use of cars, however, Soviet railroads use a more direct and more complicated method for securing current information on turnaround. This method builds up the several elements which, when added, give car turnaround in hours. The line-haul portions are determined by using the relationships:

$$\frac{\text{car-axle-kilometers}}{\text{technical speed of trains}} \quad \text{and} \quad \frac{\text{car-axle-kilometers}}{\text{section speed of trains}}$$

The difference between these gives the time spent at way stations. Major intermediate yards compute yard detention *hourly* on the basis of the car count at 6 P.M. plus receipts less dispatchments. Origin and destination stations keep records of each car received or dispatched, showing by car number the time attributable to loading and unloading, separated into operations conducted by the railroad and those conducted by other enterprises, and time spent in yard operations. Detailed instructions are given for the inclusion or exclusion of cars from the working fleet. A disparity, called undistributed time, exists between the aggregate car time accounted for in this manner and the total car time of the working fleet calculated as previously described. This has run in recent years between 2 and 2.5 per cent of total car time compared with 10 per cent in 1940. Since 1952 the unaccounted-for time has been distributed proportionately among the several elements making up the complete car turnaround.[64]

[64] Iakubov, *Osnovy zhelez. statistiki,* pp. 168 ff.

TABLE 20

COMPARISON OF FREIGHT CAR TURNAROUND TIME, UNITED STATES AND SOVIET UNION, BY COMPONENTS
(days)

	United States		Soviet Union			
	circa 1910[a]	1954[b]	1934[c]	1935[c]	1940[d]	1958[e]
Road movement (loaded plus empty)	1.49	1.53				
Road delays	0.15	0.19	3.02	2.66	2.11	1.36
Intermediate yards and interchanges	4.03	4.58				
Movement between terminal yard and loading and unloading tracks	1.74	2.10	3.84[f]	3.44[f]	2.90[f]	2.69
Repairing cars and their movement between yard and repair tracks	1.34	1.52	[g]	[g]	[g]	
Surplus cars and movement to and from storage	0.75		[g]	[g]	[g]	
Total responsibility of railway	9.50	9.92	6.86	6.10	5.01	4.05
Loading and unloading	4.00	4.00				
Delay because of bill to order, reconsignment, plant use, etc.	0.50	0.50	1.91	1.61	2.36	
Delay due to Sundays, Saturdays, and 7 holidays per year	0.90	1.22				
Total responsibility of shipper	5.40	5.72	1.91	1.61	2.36	1.77
Total turnaround	14.90	15.64	8.75[h]	7.69[h]	7.37	5.83

[a] L. F. Loree, *Railroad Freight Transportation,* New York, 1922, pp. 263 f.

[b] L. K. Sillcox, "Goal: 100 Miles a Day," *Railway Age,* Nov. 28, 1955, p. 31.

[c] See Appendix A.

[d] Zagliadimov, *Organizatsiia dvizheniia,* p. 384.

[e] *Narodnoe khoziaistvo SSSR v 1958* [The USSR National Economy in 1958], Moscow, 1959, p. 556.

[f] It is possible that movement to and from loading tracks in the Soviet data is included in the figure given below for loading and unloading rather than here.

[g] Light repair cars, while included in the U.S. serviceable stock, are believed to be excluded from the Soviet "working fleet." Hence this element disappears from Soviet turnaround. The same is true of surplus cars.

[h] Total does not agree with detail because of rounding.

in an average detention of 10.7 hours. Soviet yard detention at stations with a car turnover exceeding 200 cars daily is computed on the basis of cars on hand each hour, the figure being presumed to remain unchanged until the next hourly count. The car-hours thus determined are divided by one-half the sum of the cars received and dispatched. Cars received and dispatched in solid trains are included in the count. It is probable that a tendency to underreport cars on hand reduces this figure, but some of the differences between Soviet and U.S. detention result from different conditions, e.g., a more even flow of cars through yards over the week, the absence of so large a branch-line network, the absence of a great multiplicity of routings between principal points which compel the longer holding of cars for many classifications, the absence of prior classification as an accepted practice on U.S. railroads in 1910, and the much heavier freight traffic density on the Soviet roads in 1940 than prevailed on U.S. roads in 1910. As it appears that the movement to and from loading tracks of shippers is not included in the Soviet data on detention at intermediate yards and neither the light repair of cars nor the movement and storage of surplus cars is included in Soviet turnaround, we may reduce the duration of the U.S. railroad responsibility of 9.50 days by the sum of these elements, or 3.83 days, giving a figure of 5.67 days to compare with the Soviet 5.01. It will be observed, however, that the Soviet figure had been brought down by almost a day by 1958.

When 1.74 days for movement between terminal yard and loading and unloading tracks is added to the 5.40 days shown as the responsibility of the shipper in the United States, we have 7.14 days for U.S. turnaround to compare with 2.36 days in the Soviet Union. The latter is in effect a residual, and it is understated to the extent that the active car stock is understated, but overstated to the extent that detention at intermediate terminals may have been minimized. The items for delay because of Sundays, holidays, and traders' practices presumably have no counterpart in the Soviet system that is in any respect comparable. If they are deducted we have: United States, 5.74 days; USSR, 2.36 days. These remnants presumably represent in each country the movement of the empty to the point of loading, loading the car, switching the load to train yard of origin, switching the loaded car to the unloading track at destination, unloading the car, and switching out the empty. Not all of these moves are encountered in every car turnaround as cars unloaded at a plant may in both countries be appropriated for outbound loading. This practice may well be more common in the Soviet Union than here because of

the lesser diversity of car types, but there should not be any great differences from our 1910 conditions as the bulk of specialized cars are of more recent development.

Although it is believed that the understatement of turnaround is primarily concentrated in the element now under discussion, it is to be observed that the outstanding favorable factor for high car utilization on the Soviet railroads is the enforced cooperation of shippers in the prompt loading and unloading of cars. From what is known under this head, it would appear that instead of four days for loading and unloading in the United States, not more than one day should be allowed in Soviet practice. Hence our residuals come very close together and it would appear that the differences in turnaround can, for the most part, be explained. The available evidence indicates that shipping and receiving divisions of industrial plants are expected to perform loading and unloading operations around the clock seven days a week and to speed up car movement even when other plant sections are closed on Sundays and official holidays. Daily carloading data support this presumption, for the available daily carloading data for 1933 and 1934 do not indicate any significant weekly periodicity.[65] Whereas American shippers have been accorded forty-eight hours free time computed from the first 7 A.M. *after* the car is placed for loading or unloading, Sundays and holidays excluded, and are protected against bunching and against many adverse weather conditions which may affect the unloading of certain types of freight, Soviet shippers are given norms adjusted to the commodity and size of car and expressed in hours. In addition, American shippers generally enjoy an extra twenty-four hours free time for each diversion or reconsignment and in movements that require transfers to water carriers up to seven days free time is commonly provided, sometimes more in the export trades. It appears that, on the average, shippers come close to utilizing the free time available to them. Ordinarily penalty demurrage is not assessed, the standard demurrage rate differing little from the per diem rental rate and being ordinarily insufficient to discourage the holding of cars. Nor are incentives accorded for quicker car handling except as average agreements may permit fast handling of some cars to offset the slow handling of others. Inciden-

[65] A. Iakobi, *Zheleznye dorogi SSSR v tsifrakh* [USSR Railroads in Figures], Moscow, 1935, pp. 114-117. This factor also helps explain the greater average terminal detention of U.S. railroads, for a marked reduction in car dispatchments normally occurs on Sundays and holidays and certain classifications cannot be dispatched in the absence of train service.

tally, the demurrage tariff does not apply to cars loaded at coal mines where the holding of no-bills[66] sometimes goes to extremes.

The established Soviet norms for the loading and unloading of cars by shippers are given by Popatov as they apply to nonmechanized operations.[67] They are differentiated by commodity and by type of car. They range from one hour for piece goods in cars with a capacity of under forty tons to five hours for glass, bottles, etc., in cars with a capacity of over forty tons. Fines are collected by the railroads for the detention of cars beyond the established norms while premiums are paid to shippers and receivers of freight for accelerated loading and unloading of equipment.[68] It appears, however, that loading and unloading norms are, from time to time, adjusted and that shipping ministries can, on occasion, bring effective pressure to bear to secure more liberal norms. Moreover, in recent years certain ministries, notably those for coal, metals, lumber, construction materials, have tended to fail to meet the norms and hence have come in for a good deal of criticism.[69] Apparently the railroads have not been without fault, for Beshchev, calling attention to the fact that detention in loading and unloading has been slow in decreasing and stood in 1953 at 2.3 hours above 1940, criticized railway managements for increasing norms without cause.[70] The action of the Tomsk Railroad in raising the norm for the Kuznetsk Metallurgical Combine from 9.5 hours in 1950 to 17.7 hours in 1953 is cited with marked disapproval. The decline in 1953 in what is referred to as "idle time" at shippers' sidings was only 0.7 hours, according to Beshchev, and total turnaround time was short of the goal by approximately one hour. Shippers were called upon to deliver loaded cars more evenly throughout the hours of the day. The decided difference in relationships between shipper and carrier in the Soviet Union, compared with the United States, is adequately discussed elsewhere and need not be dealt with further here.[71] That it has a significant favorable effect upon car turnaround cannot be doubted.

In considering the over-all effects of the rapid car handling that appears to be enforced, it is well to observe that a rapid car turn-

[66] No-bills are cars loaded prior to preparation of bill of lading, often because the contents have not been sold and the destination is, therefore, unknown.

[67] V. P. Popatov and A. T. Deribas, *Kommercheskaia eksploatatsiia zheleznykh dorog SSSR* [Commercial Operation of USSR Railroads], Moscow, 1950, Appendix 4, p. 399.

[68] *Ibid.*, p. 111.

[69] L. M. Kaganovich, in *Pravda*, May 24, 1954, p. 3.

[70] B. P. Beshchev, then Minister of Transport, in *Pravda*, May 19, 1954, p. 2.

[71] Hunter, *Soviet Transportation*, pp. 128-130.

around is secured in considerable part by higher proportionate inputs—in all likelihood, primarily labor inputs—by shipping and receiving installations. Scant evidence has come to our attention concerning facilities or methods used by Soviet industrial plants, but the impression created is of the use of overwhelming quantities of ordinary labor. A larger portion of freight, perhaps 40 per cent of the total, moreover, moves through railroad-operated freight stations and is thus loaded and unloaded by railroad forces.[72]

Certain Measures of Efficiency

Despite important misrepresentations in the Soviet statistics, it is apparent that an intensive utilization of permanent way, terminals, motive power, and equipment is secured. This is achieved, in part, at the expense of heavy inputs of other resources. Although only a fragmentary picture can be constructed of these other inputs which affect the efficiency of operations, some insight can be secured from the data developed in connection with this study. Serious difficulties of interpretation and comparison, however, confront the student.

FUEL

A major input in railroad transportation is fuel which, in the Soviet case, is still almost entirely coal.[73] It is customary to measure the consumption in pounds per thousand gross ton-miles or other such units. Such a measure is reported for the Soviet railroads, but it is quite obviously not computed on the same basis as for U.S. railroads and does not, therefore, afford a direct basis of comparison. The Soviet data, presumably applying to all classes of freight and passenger service, in kilograms per 10,000 gross ton-kilometers are given in Table 21. U.S. data are given in pounds of coal per thousand gross ton-miles for freight service only. In earlier years passenger service fuel consumption was reported on a ton-mile basis. There are important differences in the methods of reporting data, however. The Soviet data equate all fuel to a 7,000-calorie per kilogram standard, whereas the U.S. data are based on actual tons consumed but equate oil fuel and electricity on a calorie basis to the average characteristics

[72] By contrast, over 90 per cent of freight in the United States other than that transshipped to or from water moves between industrial sidings and, of the remainder, the greatest part is loaded and unloaded by shippers and receivers.

[73] Fuel approximates 18 per cent of transportation expenses of Class I railroads of the United States and approximately 32 per cent of all purchases of supplies and materials.

TABLE 21

LOCOMOTIVE FUEL CONSUMPTION, SOVIET RAILROADS, 1928-40 AND 1945-59

(kgs. of 7,000-calorie units per 10,000 gross ton-kms in freight, passenger, and yard work)

	All Locomotives	Steam Alone
1928	201	301
1929	292	292
1930		
1931		
1932	282	282
1933	288	288
1934	262	262
1935	252	252
1936		
1937	269	269
1938		
1939	249	249
1940	248	248
1945	281	
1946	286	
1947	291	
1948	254	257
1949	232	236
1950	221	225
1951	212	217
1952	206	211
1953	199	205
1954	195	201
1955	185	194
1956	184	196
1957	171	183
1958	163	179
1959	156	180

SOURCE: 1928, 1932, 1937, 1940, 1950-58: Iakubov, *Osnovy zhelez. statistiki*, p. 248; 1929, 1933-35: *Sotsialisticheskoe stroitel'stvo SSSR* [Socialist Construction in the USSR], Moscow, 1936, p. 435; 1939, 1945-57: Hunter, *Soviet Transportation*, p. 307; 1948-49: *Tekhnicheskii spravochnik zheleznodorozhnika* [A Technical Handbook for Railway Men], Moscow, 1955, Vol. II, p. 243, where the figures are displaced by one year; 1959: *Zheleznodorozhnyi transport* [Railroad Transportation], 1960, No. 3, p. 35.

of coal burned on each individual railroad. They are not, therefore, designed to be comparable between railroads, and the average consumption for the system cannot be referred to a specific quality of coal. Finally, the Russian data are roughly 65 per cent of actual consumption, this adjustment being made in recognition of "the coefficient of useful action of the steam boiler. . . ."[74]

[74] T. S. Khachaturov, *Ekonomika transporta* [The Economics of Transportation], Moscow, 1959, pp. 214-215.

The U.S. data for a selection of years prior to extensive dieselization, and for freight service, Class I railroads, are:

Pounds of Coal per 1,000 Gross Ton-Miles[75]			
1936	119	1945	116
1938	115	1946	116
1940	112	1947	114
1942	111	1948	111

It would be illustrative to convert the Soviet data into pounds per thousand gross ton-miles, but, as indicated, no direct comparisons can be made because of the difference in the method of computing the average and because the Soviet figure includes the passenger service. The best Soviet prewar performance was in 1940, which was the equivalent of 123.4 pounds per thousand gross ton-miles. This was a substantial improvement over 1929 when the figure stood at 145 pounds. Postwar consumption was higher for a few years, reaching a peak of 144.7 pounds in 1947. Since then improvement has been steady and the figure, for steam locomotives only, reached 101.5 pounds in 1953. Substantial modernization of Soviet steam power in recent years no doubt contributed to the sharp reduction in consumption in the period since 1947, as did the retirement of older power and replacement with new. Great emphasis has also been placed upon fuel economy. Yet it seems impossible fully to explain so great an improvement.

For 1940, however, we may approach the problem in another way. The transport industries are reported to have consumed 49.5 million tons of coal in that year, or 30.0 per cent of total coal consumption for all purposes.[76] The exact coverage of this consumption is not wholly clear, but information on the use of other fuels has a bearing on it. Little wood appears to have been used for locomotive fuel in 1940. In 1942 some conversion to wood firing is reported on the Northern Railway and apparently in scattered fashion elsewhere. Wood reached 11.5 per cent of total consumption in 1943, but by 1946 was down to 0.3 per cent. Petroleum fell from 8.1 per cent in 1940 to 6.8 per cent in 1943 and to 2.6 per cent in 1946. Brown coal, however, increased from 6.3 per cent in 1940 to 17.02 per cent in 1943 and 21.6 per cent in 1946. It is not clear whether the figure given for 1940 transport consumption includes or excludes brown coal.[77]

[75] *Statistics of Railways in the United States,* 1946 and 1948, I.C.C., Table 60.

[76] N. A. Voznesenskii, *Voennaia ekonomika SSSR v period otechestvennoi voiny* [Soviet War Economy During World War II], Moscow, 1948, p. 69.

[77] Comparability with U.S. data is, therefore, in doubt. The U.S. data include lignites.

We may reduce Soviet consumption by 10 per cent to eliminate consumption by transport other than rail. We may reduce gross ton-kilometers by 8 per cent to eliminate those produced by use of petroleum fuel and by 10 per cent for those produced by electric power. Gross ton-kilometers must, however, be estimated. At Soviet load factors and equipment weights, passenger-kilometers come close to measuring gross ton-kilometers in passenger train service. Freight car-kilometers can be estimated from average kilometers per car-day and from the number of cars reported in the working fleet. An average weight per two-axle unit can be assumed. The resulting data may be converted into ton-miles. Thus we have 486.1 billion gross ton-miles produced by coal-burning steam locomotives with a consumption of 44.7 million metric tons of coal, or 49.17 million short tons. In 1940, 96 per cent of U.S. gross ton-miles, or 1,134.6 billion, were produced by steam power with a consumption of 96.1 million equivalent tons of coal.[78] Thus we have 9.9 billion gross ton-miles produced on the Soviet railroads for each million tons of coal, compared with 11.8 billion ton-miles per million tons of coal on U.S. railroads in that year. Such a comparison is by no means conclusive, involving as it does a number of estimates and adjustments as well as some doubt about the comparability of the basic data. From the known characteristics of Soviet steam power, however, it would appear certain that consumption would be heavier per thousand gross ton-miles on equivalent profile than for the more modern and complicated power prevalent in the United States in 1940. On the whole, Soviet profile appears to be more favorable than is the case on American roads, which would suggest that, with power of equivalent thermal efficiency similarly maintained, with similar quality of coal, and with equally efficient firing, Soviet consumption should be less than United States consumption per thousand gross ton-miles. These equivalences quite clearly did not exist and heavier consumption results.

LABOR

There appears to be no doubt that employment on the Soviet railroads far exceeds our own and that productivity per worker, as measured in composite freight and passenger ton-miles per worker, is much lower. No sharply defined conclusions should be drawn from the

[78] Oil burned in steam power was converted into coal equivalents in accordance with I.C.C. reporting requirements on the basis described earlier. These equivalents for individual railroads are given in *Statistics of Railways in the United States*, I.C.C., 1946, Table 73.

data as the coverage of the Soviet operating labor force is not fully understood while our own employment by steam railroads has been affected from time to time by the amount and character of work placed with outside firms, by fluctuations in the amount of construction, and by the degree to which such construction has been contracted for rather than performed by the carriers' own forces. Much such work is mixed in character. Not since 1929, however, have American railroads (including the Pullman Company and express companies) had as high an employment as the Soviet railroads have shown in each of the last three years.

Data on the Soviet railway labor force are given in series C-39 and C-40 in Appendix C. It will be observed that series C-40, which gives estimates of the operating labor force, is occasionally derived from the productivity data of series C-39 and the composite traffic data of series C-38. It will also be noticed that, during a part of the period, it has been possible to compute a more inclusive series which also embraces the employees in the work train service. The bulk of new railroad construction is performed by other organizations whose employees are not included here. Undoubtedly, however, much work train service is operated in support of such construction.

The precise content of the railway operating labor force is difficult to determine from the available data, and a reconciliation of its composition with that of U.S. railroads calls for considerable speculation. The distribution by "railroad management branches" is given for 1950 as follows:[79]

	Per Cent
Locomotive service	23.6
Track maintenance	22.3
Traffic management	17.6
Freight car service	11.0
Passenger service	6.8
Signaling and communications service	4.2
Commercial service	2.6
Building and installation maintenance	0.8
Railroad division and administrative agencies	4.0
Other	7.1
Total	100.0

The classification differs fundamentally from that employed in the United States since it mixes transportation and maintenance functions and thus makes direct comparisons impossible. Were the full detail of the Soviet labor force known in a breakdown similar to

[79] I. V. Kochetov, *Zheleznodorozhnaia statistika* [Railroad Statistics], 2nd ed., Moscow, 1953, pp. 156 ff.

that of the United States by type of position, a more effective analysis could be undertaken. Some immediate differences both in coverage and function are, however, obvious. Some components of the Soviet work force are absent in the American system, e.g., political agencies and other organizations which account for 4.5 per cent of the Soviet railroad force. The identifiable administrative echelons of the Soviet system are at much lower strength than in the American system. The traffic departments of American railroads—rates, sales, advertising, and industrial development—have but a feeble counterpart. The personnel required for certain functions, e.g., heavy locomotive and car repair and new line construction, are included in the Ministry staffs, as are the personnel charged with the primary budget functions, whereas in the United States these are included in the employment of the railways.[80] As the majority of timber-treating plants are operated independently or by subsidiaries in the United States, their inclusion in Ministry forces does not appear to add another element of incomparability. A primary obstacle to understanding the composition of the Soviet railway force is, however, the difference in the reporting of personnel by the primary functions of railway operation, which at least suggests a difference in organization concepts.[81] In attempting

TABLE 22

DISTRIBUTION OF RAILROAD LABOR FORCE IN UNITED STATES AND SOVIET UNION, 1950
(per cent)

United States		Soviet Union	
Transportation			
Train and engine service	20.9	Locomotive service	23.6
Yard forces	1.3	Traffic management	17.6
Other	11.6	Freight car service	11.0
		Passenger car service	6.8
Maintenance of equipment	28.2		
Total	62.0	Total	59.0
Maintenance of way	19.7	Maintenance of way (incl. signals, buildings, and electrification)	28.0
Professional, clerical, general	18.3	Other	13.0
Total	100.0	Total	100.0

SOURCE: For U.S., *Statistics of Railways in the United States*, I.C.C., 1950; for USSR, see text above.

[80] I. V. Kochetov, *Zheleznodorozhnaia statistika* [Railroad statistics], 1st ed., Moscow, 1948, p. 163.

[81] It would appear, for example, that the locomotive department more nearly parallels British than American practice, embracing not only the shop and engine house forces but the engine crews as well.

to compare the Soviet with the U.S. distribution of workers, we must effect combinations that deprive the totals even of certain principal breakdowns commonly employed in summary employment statistics, for we must combine transportation and maintenance of equipment categories (see Table 22). Maintenance of equipment is underrepresented in this comparison since the heavy repair forces are under the Ministry. Such forces are the equivalent of 8.8 per cent of the railway operating staff and their addition would bring the transportation and maintenance of equipment forces to a percentage slightly above that for the United States. So far as appears from these data—and the evidence is highly inconclusive—the principal difference in composition of the Soviet working force in the major departments of operation is the much larger proportion of the force devoted to maintenance of way. This is to be expected in view of the limited degree of mechanization of trackwork in the Soviet system.[82]

What little evidence there is suggests that the operating labor force as reported for the Soviet railways is somewhat less inclusive than that reported by railways of the United States.[83] Other differences that affect productivity calculations concern the count of workers upon which the force is based. The U.S. data represent the averages of twelve midmonth counts. The Soviet data employed for the productivity calculations appear to be developed from actual hours worked adjusted to standard per worker expectancy. There is the possibility that a difference in concept results, therefore, in a relative overstatement of workers employed on the U.S. railways. We are not in possession of man-hours worked on the Soviet railways, hence we cannot progress to hourly productivity data which would be far more useful than those which we possess. Nevertheless we may acquire some notion of the relative inputs of labor if we relate the available data to the traffic data. As we do so, we should bear in mind the upward bias of Soviet traffic data and the probable downward bias of employment data. If, therefore, we find a larger labor input per traffic unit in the Soviet Union, we shall have understated the difference.

Because of differences in the quality of service, both freight and passenger, it would be desirable to develop measures of the volume

[82] By contrast, mechanization of trackwork for new construction appears to have been carried rather far along lines similar to British railways.

[83] As the categories which account for the overwhelming proportion of operating and maintenance workers are contained in the series of both countries, this is not a bar to securing some general understanding of the relative use of labor.

of service produced weighted by value. This we are unable to do and must confine ourselves to the employment of ton-mile data. As observed elsewhere, the Soviet composite traffic series is a simple addition of ton- and passenger-kilometers, which is a reasonable meshing of the series to represent probable gross ton-kilometers in the two services. Passenger service in the United States is, however, of a different order and is operated according to entirely different standards for speed, weight of equipment per seat, passenger load factor, non-revenue space, and other matters. While there are certainly differences in the quality of freight service, notably in train speed, these differences are smaller than in the passenger service. In comparing the two systems to secure some approximation of labor productivity, we would be fully justified in assigning greater weight to passenger-miles in the United States series. The disparity, however, turns out to be so great that no considerable speculation on this point is useful. The data are developed in Table 23.

TABLE 23

COMPARISON OF LABOR PRODUCTIVITY IN UNITED STATES AND SOVIET UNION, SELECTED YEARS

	United States[a]			*Soviet Union*[b]
	Composite Metric Ton-Kilometers[c] (billions)	Employees[d] (thousands)	Ton-Kilometers per Employee (thousands)	Operating Ton-Kilometers per Employee (thousands)
1930	661.1	1,517	435.8	204.4
1932	404.1	1,052	384.1	247.4
1934	462.0	1,027	449.8	251.6
1936	584.1	1,086	537.9	336.9
1938	499.2	958	521.1	358.8
1940	635.4	1,046	607.5	380.6
1945	1,215.2	1,439	844.5	273.9
1949	879.0	1,207	728.2	373.4
1950	762.5	1,236	778.7	409.9
1953	981.6	1,221	803.9	488.7
1954	890.4	1,079	825.2	506.6
1956	1,025.6	1,123	913.3	622.4
1958	889.1	908	979.2	737.8

a From *Statistics of Railways in the United States,* I.C.C., of each year.

b Series C-39, col. 2, in Appendix C.

c Net ton-miles converted to metric ton-kilometers plus passenger-kilometers.

d All line-haul railroads. Excludes switching and terminal companies, Pullman Company, and express companies.

It will be observed that a substantial drop in productivity occurred in the Soviet system during the war and that, although the position improved with some rapidity, it was not until a year after the prewar traffic level had been passed that prewar labor productivity was attained and passed. In the U.S. system it will be observed that the wartime level of 1945 was not again attained until after 1954, despite the extensive mechanization of trackwork and wholesale dieselization. Declining traffic is unfavorable to high labor productivity. Moreover, a fundamental shift was produced by the adoption of the forty-hour week for various classes of employees in 1947-50. That Soviet railroads since 1950 appear to have exceeded the U.S. level of 1930 must be regarded as a creditable performance in the light of the tools with which they have to work. An argument can be made, however, that as late as 1954 Soviet productivity had not attained our 1930 level, if proper allowance could be made for the bias of the Soviet data and for the differences in the quality of service rendered by the two systems. Improvement has continued and the 1958 record was as good as the best U.S. prewar performance. Soviet productivity should continue to increase as maintenance-of-way workers are better provided with equipment and as dieselization progresses. The latter should not only permit increased train loading and more rapid yard work, but also a reduction in the size of train crews and the elimination of second engine crews when double-heading is resorted to, except where mixed equipment requires the second engine to be cut into the middle of the train. The margin between U.S. and Soviet productivity has obviously been narrowing, and this trend may be expected to continue with dieselization of the Soviet system. As the next section suggests, the Soviet railways appear to be securing far more salutary results from diseselization than U.S. railroads have achieved.

Effects of Partial Dieselization

The comparisons in this chapter thus far have been confined largely to the Soviet experience before 1954 when more than 90 per cent of the freight working was carried out by steam traction. The U.S. data employed for comparison have generally not been later than 1944 when more than 94 per cent of U.S. road freight service was still accomplished behind steam locomotives. The substantial transition of power in both countries, although it is very recent in the Soviet Union, makes possible some appraisal of the effects of the shift in the two countries. Such an appraisal is subject to many qualifications, the most serious of which are:

1. Soviet freight traffic has been increasing rapidly during the period of transition whereas that of U.S. railroads has exhibited a generally declining trend which has been punctuated by a number of years of depressed traffic volume, and the year during which U.S. roads neared the Soviet 1960 percentage of steam working was a badly depressed year.

2. Soviet steam power at the time the transition began was generally of less modern design, smaller average unit capacity, and lower efficiency than that in service on U.S. railroads at the beginning of the transition.

These differences in part explain the greater improvement in the Soviet performance which has occurred, but it is questionable whether they do so completely. The comparative periods of transition are shown in Table 24. Thus it will appear that, broadly speaking, U.S.

TABLE 24

PERCENTAGE OF TOTAL GROSS FREIGHT TON-KILOMETERS PERFORMED BY STEAM TRACTION, U.S. AND SOVIET RAILROADS

	U.S. Railroads		Soviet Railroads
1944	94.6	1954	89.8
1945	91.1	1955	85.9
1946	88.2	1956	82.8
1947	85.6	1957	79.4
1948	76.7	1958	73.5
1949	63.1	1959	66.5
1950	53.9	1960	58.5
1951	45.5	1961	

SOURCE: For U.S., derived from detailed figures in *Railroad Transportation: A Statistical Record, 1921-1955*, Washington, 1956, p. 26. For Soviet Union, S. K. Danilov (ed.), *Ekonomika transporta* [Economics of Transportation], Moscow, 1956, p. 327; *Vestnik statistiki* [Bulletin of Statistics], 1959, No. 4, p. 92; *Zheleznodorozhnyi transport* [Railroad Transportation], 1957, No. 3, p. 31, and 1960, No. 3, p. 34. The 1960 estimate assumes an eight-point drop, following a seven-point drop in 1959 and a six-point drop in 1958.

railroads moved from 90 to 60 per cent steam between 1945 and 1950 while the USSR moved from 90 to 60 per cent steam between 1954 and 1960.

It will be instructive to compare the behavior of certain operating statistics during the respective transition periods. This is done in Table 25 for measures which one would expect to be particularly affected in a favorable direction by the increasing use of diesel power.

TABLE 25

COMPARISON OF RAILROAD OPERATING STATISTICS, UNITED STATES AND SOVIET UNION

United States		Soviet Union	
AVERAGE LOCOMOTIVE-MILES PER LOCOMOTIVE-DAY			
1945	118.4	1954	257
1949	112.5	1959	345
Absolute change	−5.9	Absolute change	+88
		Per cent increase	34
AVERAGE GROSS TRAIN LOAD (TONS)			
1945	2,386	1954	1,660
1949	2,534	1959	2,037
Absolute change	+148	Absolute change	+377
Per cent increase	6.2	Per cent increase	22.7
AVERAGE FREIGHT TRAIN SPEED			
(m.p.h.)		(km.p.h.)	
1945	15.7	1954	22.9
1949	16.9	1959	27.2
Absolute change	+1.2	Absolute change	+4.3
Per cent increase	7.9	Per cent increase	18.9
GROSS TON-MILES (OR KILOMETERS) PER TRAIN-HOUR[a]			
(miles)		(kilometers)	
1945	36,954	1954	38,010
1949	42,346	1959	55,400
Absolute change	+5,392	Absolute change	+17,390
Per cent increase	14.6	Per cent increase	45.7

[a] Gross ton-kilometers per freight train-hour are given by Holland Hunter in *Comparisons of the United States and Soviet Economies*, Joint Economic Committee, Congress of the United States, Washington, 1959, p. 197; *Hearings, November 13-20, 1959*, Joint Economic Committee, Washington, 1960, p. 91.

It will be observed that the improvement in these indexes for U.S. roads was very modest compared with the achievement recorded in the Soviet Union. U.S. freight traffic measured in ton-miles fell by 23 per cent from 1945 to 1949. On the other hand, Soviet freight traffic grew by 67 per cent. In the USSR all elements of plant were being used more intensively and steam power was being augmented and improved even while diesel power came on the road in increasing quantities. In the United States the terminal year of the comparison was marked not only by a poor level of business, but also by strikes which had far-reaching effects upon the movement of traffic. When all of these things are allowed for, however, the Soviet performance appears very good indeed. And even if 1950 U.S. data are used, carrying a little further into the dieselization movement, the U.S. performance is not notably better.

It is probable that train loading and movement in the Soviet Union has also been favorably influenced by significant improvement in the permanent way and signaling. Very little information has come to hand on these points. Condition of track is, in any event, difficult to measure and express. Yet improvement in line and surface permits both increased speed and train loads. And the improvement in signaling and more abundant provision of auxiliary trackage (passing sidings, crossovers, etc.) may materially improve the rate of movement over the road. Some scattered evidence suggests substantial improvement in track. Thus 72 per cent of all main track is said to have had rail weighing at least 43.6 kilograms per running meter in 1958,[84] compared with 56 per cent in 1954 and 17.2 per cent in 1940.[85] By 1957 over 20 per cent of track was laid on crushed stone ballast, while crushed stone and gravel ballast together accounted for 40 per cent.[86] In 1954 some 37.4 per cent was on stone or gravel compared with 24.4 per cent in 1940.[87] Hence a great improvement in the mileage laid with heavy rail has been effected along with some improvement in ballast. Both these developments should have resulted in improved track conditions.

[84] Khachaturov, *Ekonomika transporta*, p. 445.
[85] Danilov, *Ekonomika transporta*, p. 363.
[86] Khachaturov, *Ekonomika transporta*, p. 445.
[87] Danilov, *Ekonomika transporta*, p. 363.

CHAPTER 5

Conclusions

Our examination has led to the conclusion that transportation of more than local importance in the USSR is overwhelmingly supplied by railroad. Our more detailed examination of the statistical record open to us has, therefore, been confined to this form of transportation. We have sought to appraise the rate of traffic growth and to ascertain in a general way how this traffic growth has been accommodated through the development of the railroad system and through the control of railway operations. And we have sought by comparison of operating statistics to understand Soviet rail operations sufficiently to satisfy ourselves that, bearing in mind the bias in the data whose direction is known, the reported traffic could reasonably be expected to be handled with the plant and methods available.

The inquiry has led us through the toils of statistical manipulation, changing coverage and definitions, reporting inadequacies, the absence of conventional audit procedures, and the pressures on employees at all levels to resort to misrepresentations. Yet we have concluded that, when general allowances are made, the statistical record is reasonably congruous and can be interpreted suitably for our purposes. The general level of Soviet development, however, has compelled us to orient our thinking to the first two decades of the present century in our own railway development to find conditions more nearly comparable. Even for this period, however, very significant differences must be noted.

Whether considered in relation to land area, population, or traffic volume, the Soviet rail network is small. It represents essentially a planned system of main routes without competitive overlap and with feeder lines developed sufficiently only to support major sources of tonnage on a minimum basis. Its growth has been carefully controlled and has been minor in comparison to the growth of traffic moved over the system. Development since 1926 has, therefore, been intensive and has centered on procuring as much transport service as possible from the existing network, filling it out only in cases necessitated by new industrial and agricultural development or where hauls could be notably shortened by construction providing cut-offs between existing segments of the system. To a degree unfamiliar in the West, plant location has been forced to conform to the railway location,

and agricultural areas have been forced to convey their output to the rail system, usually by primitive means.

The growth of Soviet freight traffic has been very rapid; rates of growth have been accomplished over relatively long periods which were equaled or approximated in the United States only during several brief periods before 1900. The growth of rail traffic has been more rapid than that of total traffic, as railroads have been required to bear an increasing share of the demands made by the production phases of the economy. Yet the Soviet Union was in the beginning so ill provided with mechanized transport that this growth is measured from a diminutive base. It is of importance that growth has continued at a rapid rate since the recovery of the pre-World War II level, for 1940 affords a very substantial base from which to measure postwar growth. Yet the rapidity of Soviet growth from 1926 to the present leaves it still with only two-thirds the volume of intercity freight transportation generated in the United States. And on a per capita basis the Soviet provision of freight transportation is a still smaller proportion of the U.S. level. The rapidity with which the volume of freight transportation in the USSR has grown in relation to that in the United States is, however, certainly of great significance. In 1928 the United States produced six times as much transport, in 1940 only 2.7 times as much, and in 1959 only 1.5 times as much. Yet the U.S. volume remains nearly 500 million ton-miles above the Soviet volume in a year whose volume was adversely affected in the United States by a prolonged steel strike and other adverse factors.

During the whole Soviet period freight transportation has never been in abundant supply. Generally it has been tight, and agriculture and industry have been forced to accommodate themselves to a "tempo" of transport operation which seeks to secure a steady use of plant and equipment throughout the year. Added tasks and expense have, therefore, been thrown on other areas of the economy which are rather consistently covered up. Nevertheless, it appears that transportation has never been so seriously underprovided as to place a noticeable restraint on the growth of industrial output. The so-called transportation crisis of the 1930's comes nearest to such a restraint and was regarded as extremely serious. Requirements are not met as promptly at any time as they are in the West, but in any given year the economy's output tends to get moved so that shortfalls of production are not readily traceable to failures of the transport system.

Over the period studied, it is likely that the volume of freight transportation generated affords a reasonable quantitative measure

of the total output of goods and of the movement of that output from year to year. We may state with considerable confidence that the traffic data, both tons originated and ton-kilometers, are overstated. We cannot measure the amount of this overstatement, but it may easily come to as much as 10 per cent. In short, it is not insignificant and cannot, therefore, be ignored when using the Soviet data. The composition of Soviet rail traffic also affords somewhat of an index to the make-up of the Soviet economy. It is heavy in fuels, ores, primary materials, and basic construction materials. It is light in manufactured products, particularly those representing the higher stages of manufacture.

Soviet transport policy has manifestly sought to keep capital investment at a minimum and to sacrifice the quality of performance as well as the inputs of fuel and labor to this objective. It has not been as successful as the statistics would suggest, for not only is traffic overstated, but equipment is understated. Nevertheless, the utilization secured from track, yards, motive power, and cars is very high, and strenuous efforts are made to improve utilization through exhortation and through a system of incentives and penalties based on efficiency indexes, a practice almost unknown elsewhere in the railroad world. While these practices invite misrepresentation at all levels, they certainly stimulate performance. Of greater importance to high utilization, however, is the limitation of the plant and the restriction of traffic to its confines. The traffic is virtually forced into a remarkably even flow in which weekly and seasonal peaks come close to disappearing. The service, moreover, is almost undifferentiated and both for freight and passenger traffic the primitiveness of service is unmitigated by any concessions to the needs or desires of shippers or travelers. No period in our own transport history provides a reasonable comparison, nor would such a period be expected to exist in a competitive system.

Soviet railway technology has remained primitive, although with the rapid introduction of diesel power and the extension of electrification, higher standards are swiftly being achieved. Except for occasional modern intrusions upon a minor scale, in the prediesel period, we must go back forty years in American railroad history for a comparison that is moderately valid. Yet the lag of technology, on the average, has been no bar to a continuing increase in the capacity of the system and we must bear in mind that the Soviet railroads today produce half again as many ton-miles as the United States railroads. It would be unfortunate to confuse obsolescence with a want of physical capacity. There is, indeed, an argument to be made that the Soviet

adjustment to its resources and skills has been a reasonably good one over much of the period. It would appear that modernization is now under way on a considerable scale and that the present program, if fulfilled, will substantially transform the railroad system. It is significant, however, that improved quality of the transport service is not cited as a major objective of modernization. Instead, improved technology, especially of motive power, is to be applied in order to attain a further expansion of capacity with a minimum capital investment and without an unacceptable increase in fuel and manpower inputs.

The sharpest contrast between Soviet and Western transport is in the concentration of the Soviet Union on the railroad for both its freight and passenger requirements. The United States since the middle 1920's and Western Europe since the second war have developed mainly by expanding the nonrail forms of transport. No counterpart is observable in Soviet history. It is likely, indeed, that no major nation has ever been so completely dependent on the railroad as the Soviet Union is today. Since rail transportation in the United States now accounts for less than 40 per cent of total intercity freight ton-miles, it is essential to make comparisons of total intercity freight transportation despite very serious statistical inadequacies in both countries in much of the nonrail transport. Moreover, the virtual absence of automobile transportation and the limited volume of air transport must be kept in mind in evaluating a Soviet rail passenger traffic one-half larger than all commercial intercity passenger mileage in the United States, in addition to the fact that the railroad substitutes for much transportation here performed by local and suburban bus systems and by rapid transit lines. Even when suburban traffic is excluded from the Soviet data, the rail passenger traffic still somewhat exceeds the total of our rail, bus, and air passenger traffic excluding commutation.

There is a rational explanation for the Soviet concentration on rail transportation. The natural waterways of the Soviet Union which are capable of improvement for navigation purposes do not mesh well with the traffic flows required by the economy. Pipeline transportation has been of limited usefulness because of the want of concentrated flows which could fill large-diameter pipe. Hence neither of these forms of transport could have been developed, although either might prove more efficient than the railroad under certain circumstances. Motor transport could not be developed, except for local purposes, because of the lack of an improved highway system. No importance

has been attached to highway development, doubtless because it is recognized that, by comparison with the railroad, truck or bus transportation is highly inefficient except on the shortest hauls and requires unacceptable inputs of fuel, labor, and repair parts, and a rate of vehicle replacement which cannot be sustained without very massive expansion of the automotive industry. Inability to secure from inland and coastal waterways a service in the long-haul transport of bulk commodities comparable to that performed in the United States, together with the long distances separating important industrial and resources concentrations, leads to an average haul for carriers other than water greater than in the United States. The comparative advantage of rail over motor transport increases rapidly with length of haul and the confinement of motor transport development to the very short hauls would seem to represent a decision favorable to the minimization of resources devoted to transport.

The emphasis placed on heavy industry in the Soviet economy and the lack of competitive distribution of consumer goods, even the lack of large-scale distribution of such goods, also create a pattern of traffic requirement capable of standardized handling in the mass and without regard to special service considerations. These conditions produce a climate highly favorable to the intensive utilization of the limited railroad plant. When allowance is made for the certain bias which overstates that utilization, we find no reason to suppose that the Soviet rail system is in any respect incapable of the performance which the traffic statistics—again allowing for bias—credit it with. In short, Soviet rail output is explicable. Even in intensity of plant and equipment, it nowhere exceeds numerous instances in this country where sufficient traffic volume has permitted intensive utilization. Traffic is spread much more evenly over the Soviet system and its flow is subject to a degree of central control that is not sought or achieved in a competitive system. Nor does the Soviet system carry the burden of superfluous and light traffic mileage that is so characteristic of the American system. Hence comparison of averages drawn from the experience of the two countries is highly misleading and contributes little to an understanding of the Soviet position.

Appendixes

NOTE: In these appendixes the sources are cited by an italicized numbering code followed by the page number. The sources are arranged by that code in the bibliography at the end of the book. In the case of articles, citations are given by an italicized number identifying the periodical or newspaper, followed by the year, issue, and page number.

APPENDIX A

Railroad Performance vs. Capital Investments During the Transportation Crisis in the USSR, 1931-35

BY GEORGE NOVAK

THE rapid growth of railroad freight traffic and the steady improvement of most operating indexes during the 1920's must have led Soviet planners to think that the railroads could continue increasing the volume of freight traffic they carried simply by raising the standards of their operating efficiency without making any substantial capital investment. The warnings of some conscientious railroad economists and engineers were discarded as typifying a "theory of limits" and, instead of providing an allocation of investments reasonably balanced between heavy industry and railroads, Soviet planners preferred to rely on constantly increasing pressure and minimum investment in the railroad plant.

This disproportionate allocation of investments in favor of heavy industry led, in the first two years of the Second Five Year Plan, to a general transportation crisis despite the high pressure on railroads to increase their operating efficiency. Transportation difficulties, which developed as early as 1930, were described by an official Soviet publication on transportation in the following terms:[1]

> Railroad transportation started off the year 1931 in poor condition. Its deterioration, which began in the middle of 1930, reached a low point in the first two months of 1931 when average daily carloadings declined to 38,800 in January and 36,000 in February. At this time transportation was the main cause for the underfulfillment of output plans in industry. Some enterprises accumulated masses of unshipped output (about one million tons of fuel in the Donbas alone); giant construction projects and factories remained without building raw materials, which caused a standstill in production. Instead of increasing, the level of industrial production dropped in January 1931 because of transportation difficulties, and in February 1931 it was back at the level of February 1930. As a result, industry fell below the level it had reached in December 1930, and suffered a setback which disorganized it quite considerably. . . .
>
> . . . Transportation really became a bottleneck in the economy. . . .

[1] 7, 1931, No. 11-12, 92.

. . . The appeal of January 15, 1931, was a turning point in the work of the railroads. . . .

. . . Average daily carloading increased to 49,300 in April, compared to 36,000 in February; the average number of bad-order locomotives declined from 158 per day in February to 61 in April; freight car-kilometers per active freight car increased from 65.4 in February to 92.3 in April. . . .

. . . However, in spite of the recovery of railroad transportation, the measures taken to sustain this recovery proved insufficient. Railroad transportation did not expand as rapidly as the building of socialism in our country.

In quantitative terms, however, the backlog of unshipped freight was quite small at this early stage compared to the backlog which developed in later years. Table A-1 presents a comparison between the average daily carloadings and the volume of unshipped freight in 1930-31.

TABLE A-1

AVERAGE DAILY CARLOADINGS AND BACKLOG OF UNSHIPPED FREIGHT, 1930-31
(thousand cars in 2-axle units)

	ADC		*Backlog*	
	1930	1931	1930	1931
January	42.8	38.8	3	50
February	42.3	36.0	3	83
March	45.9	43.9	15	112
April	48.1	49.3	14	92
May	48.4	51.5		52
June	51.0	54.6	1	7
July	47.5	52.4	2	13
August	45.0	51.1		14
September	46.7	53.7	3	37
October	48.3	55.0	8	45
November	47.2	55.4	14	49
December	42.6	49.6	21	52

SOURCE: ADC, *62*, 340; backlog, figures read off a diagram in 7, 1932, No. 9-10, 1.

The core of the transportation problem in 1933-34 becomes apparent when we compare the rate of growth of heavy industry with the performance of railroads (Tables A-2 and A-3). Average daily carloadings increased 11 per cent in the first quarter of 1934 compared to the first quarter of 1933, 8 per cent in the second, 9 per cent in the third, and 6 per cent in the fourth. The performance indexes also show some slight improvement in 1934 over 1933, but, compared to

TABLE A-2

PERFORMANCE OF RAILROADS, 1933-34

	First Quarter		*Second Quarter*		*Third Quarter*		*Fourth Quarter*	
	1933	1934	1933	1934	1933	1934	1933	1934
Average daily car-loadings	47,011	52,297	52,649	56,795	51,698	56,797	53,474	56,945
Average freight car turnaround time (days)	10.59	9.51	9.28	8.50	9.23	8.41	9.36	8.66
Freight car-kilometers per car-day	85.8	104.1	101.1	123.8	103.9	123.3	99.7	119.3
Locomotive-kilometers per locomotive-day in freight traffic	152.5	160.0	170.0	174.4	170.4	172.9	159.6	166.2
Technical speed of freight trains (kms per hr.)	21.5	21.8	23.0	22.8	22.9	22.9	21.8	22.3
Average section speed of freight trains (kms per hr.)	12.8	13.5	14.5	14.7	14.5	14.7	13.5	14.0

SOURCE: *6*, 1935, No. 11, 6.

APPENDIX A

TABLE A-3

AVERAGE DAILY OUTPUT OF MAJOR INDUSTRIAL COMMODITIES, 1933-34
(thousand metric tons)

	First Quarter		*Second Quarter*		*Third Quarter*		*Fourth Quarter*	
	1933	1934	1933	1934	1933	1934	1933	1934
Coal	190.1	245.9	201.0	248.9	206.6	274.5	231.6	272.1
Coke	23.6	34.7	27.7	38.8	29.9	40.5	30.9	41.6
Ores	33.2	46.8	37.6	58.9	43.7	65.3	46.3	69.6
Pig Iron	15.4	24.8	19.4	28.9	21.1	29.7	21.8	30.5
Steel	15.6	23.4	17.8	26.1	19.9	26.4	21.5	28.9

SOURCE: *6*, 1935, No. 11, 6.

the output of heavy industry (Table A-3), these increments appear negligible indeed. The first quarter showed a marked increase of 28 to 50 per cent, the second quarter of 23 to 60 per cent, the third quarter of 19 to 50 per cent, and the fourth quarter of 22 to 50 per cent. The quarterly increases in industrial output of major commodities were several times as great as the growth of railroad freight traffic in the corresponding period.

Moreover, the railroads had to carry more and more supplies of machinery and oil products for mechanized agriculture and a larger share of the marketed crops as the result of collectivization. At the same time, the transportation of lumber and oil was shifted from river to railroad. Under these circumstances, it is not surprising that a backlog of unshipped freight several times as great as the average daily carloadings could accumulate and last for long periods.

During this time, the railroads operated with great deficiencies, which, in the words of a Soviet writer,[2] resulted in "an increased number of catastrophes and accidents, long turnaround time of rolling stock, long detention of freight cars at all types of stations (classification, divisional, freight, and way stations), low technical and average section speeds, nonscheduled movement of trains, insufficient introduction of full trainload lots, and the absence of a real drive to speed up freight car and locomotive turnaround time."

The Soviet writer continues:[3]

> The overwhelming majority of railroad workers, including most of the Ministry and railroad agency officials, were convinced that the railroads were operating at the extreme limits of their technical resources and that the goal of 61,000 to 63,000 average daily carloadings was the upper limit of their performance.

[2] *6*, 1935, No. 11, 7.
[3] *6*, 1935, No. 11, 7.

The Scientific Research Institute for Railroad Operation and its "theorists" and "researchers" attempted to prove that the railroads were operating at the "limit" and that their performance could not be improved until industry provided new freight cars and the rolling stock was equipped with automatic brakes and automatic couplings.

These were the reasons for the poor performance of railroads. Neither the Ministry, nor the railroads, nor the research institutes tried to improve organization of operations; they did not even study the technical resources of railroads.

These often repeated official Soviet arguments and explanations of the 1933-34 transportation crisis are followed by an even more startling declaration of the magic power of L. M. Kaganovich, who apparently was responsible for the rapid recovery of transportation in 1935-36. The Soviet writer from the Ministry describes the immediate cause for the recovery in the following words:[4]

. . . and then came the history-making day for railroad transportation: February 28, 1935. The Party and the government ordered Stalin's close friend—Lazar Moiseevich Kaganovich—to take over railroad transportation.
. . . as soon as his Bolshevist hand, firm and organizing, touched the work, technical transportation resources began to be properly utilized and the management and mobilization of all the leading railroad workers started to be organized efficiently. As a result, the railroads overfulfilled their plan, for the first time, in April, by loading 61,977 cars a day.

There was indeed a marked increase in average daily carloadings in 1935-36 over 1933-34, but whether this was the result of the intra-transportation purges and the pressure applied by Kaganovich or other determining factors is another matter. Evidence indicates that the latter is at least as probable as the former. Table A-4 shows that there was an increase in the average daily carloadings *before* Kaganovich took over. This increase can be analyzed by breaking it down by causal factors. When the total increase in ADC from January to September of 1935 (24,003 freight cars per day) is distributed among the factors shown in Table A-5, it can be seen that it resulted primarily from a decrease in turnaround time of freight cars rather than from an increase in the active fleet.

[4] *6*, 1935, No. 11, 7.

TABLE A-4

AVERAGE DAILY CARLOADINGS, 1933-36, BY MONTH
(thousand cars in 2-axle units)

	1933	1934	1935	1936
January	46.3	51.8	50.7	77.6
February	46.4	53.1	56.1	76.4
March	48.3	52.0	59.2	86.7
April	52.2	55.4	62.0	89.0
May	53.8	57.2	69.3	92.4
June	51.9	57.8	72.7	89.9
July	50.0	56.7	73.0	90.4

SOURCE: *26,* 61.

TABLE A-5

BREAKDOWN OF INCREASE IN AVERAGE DAILY CARLOADINGS IN 1935 BY CAUSAL FACTORS
(cars in 2-axle units)

Increase in active freight car fleet	1,537
Increase in average section speed and decrease in time spent in motion	6,798
Decrease in demurrage of cars at loading and unloading stations	4,450
Decrease in demurrage of cars at divisional and classification stations	11,217
Total	24,002

SOURCE: Derived from data in *6,* 1935, No. 11, 10, and *26,* 61.

The reduction of the average full freight car turnaround trip by 60 kms[5] from February to September of 1935 did reduce the turnaround time in general and the demurrage at classification and divisional stations in particular (since the number of times the cars were worked at these stations was also lower). The equipping of all freight cars with hose (to connect the locomotive with automatic brake cars) also reduced the demurrage at classification stations. The extent to which the detention of freight cars at technical stations was reduced in 1935 is shown in Table A-6.

The improvement from 1934 to 1935 was not greater but rather less than from 1933 to 1934, as indicated by official Soviet statistics. It will be shown later that at least some of that reduction in turnaround time was obtained by deliberate understatement of the active fleet of freight cars.

The reduction in time spent in trains from January to September of 1935 was achieved by an in increase in train speeds and, to a very

[5] *6,* 1935, No. 11, 10.

TABLE A-6

DETENTION OF FREIGHT CARS AT DIVISIONAL AND CLASSIFICATION STATIONS, 1933-35

(hours)

	1933	1934	1935
January	13.2	11.7	10.8
February	13.2	10.4	8.3
March	13.1	9.6	8.2
April	11.5	8.7	8.0
May	10.8	8.1	7.1
June	11.0	8.9	7.0
July	10.9	8.2	7.1
August	10.7	8.1	7.5
September	10.2	8.1	7.3
October	10.1	7.8	
November	10.4	7.7	
December	12.3	9.3	

SOURCE: *6*, 1935, No. 11, 9.

minor extent (if we ignore seasonal improvement), by a decrease in time spent at way stations (compare Tables A-7 and A-11 below). Higher train speeds must have had an important part in increasing locomotive-kilometers per locomotive-day as well as in increasing

TABLE A-7

TRAIN AND ROLLING STOCK PERFORMANCE, 1935

	Average Technical Speed of Freight Trains (kms/hr)	Average Section Speed of Freight Trains (kms/hr)	Train Speed Coefficient	Loco-Kms per Loco-Day in Freight Service	Freight Car Kilometers per Active Freight Car Day
January	21.5	12.9	0.60	153.0	101.2
February	22.2	13.8	0.62	166.2	119.5
March	22.7	14.3	0.63	170.8	125.1
April	23.1	14.9	0.65	175.0	127.9
May	23.4	15.2	0.65	181.2	137.1
June	23.8	15.5	0.65	187.8	140.3
July	24.0	15.7	0.65	191.4	138.7
August	24.4	16.0	0.66	196.8	135.5
September	25.2	16.8	0.67	207.0	135.0

SOURCE: *65*, 429.

freight car-kilometers per active freight car. The latter index, however, might have been even more affected by the general Soviet practice of understating the active fleet of freight cars in daily statistical reporting. The performance of the rolling stock in 1935 is shown by month in Tables A-7 and A-8. It should be borne in mind, however, that the seasonal variations have not been eliminated from these series. It is not proper to follow the method used by Isaev[6] and

[6] *6*, 1935, No. 11.

TABLE A-8

UTILIZATION OF LOCOMOTIVE STOCK, 1934-35

	1934	*1935*			
	Annual Average	First Half	July	August	September
Gross ton-kms per locomotive in freight service	136.5	145.6	162.7		
Loco-kms per loco-day in freight service	168.6	178.1	191.4	196.5	207.0
Detention at the main engine house (hours)	8.81	7.9	7.12	5.41	5.39
Detention at the turning engine house (hours)	8.09	8.09	7.49	5.90	5.50

SOURCE: *6*, 1935, No. 11, 10.

compare the performance of railroads in September with that in January without making an allowance for the seasonal variations which tended to overemphasize the improvements achieved in September 1935.

Comparing and analyzing the annual data for 1934 and 1935, we find the improvements much less pronounced. The average daily carloadings increased by 12,376 from 1934 to 1935, compared to a 24,003 increase from January to September 1935. The distribution by causal factors of these increments was also quite different in the two cases. The increase in average daily carloadings attributable to the increase in the active fleet of freight cars was only 6.4 per cent (1,537 cars) of the total increase in ADC from January to September 1935, and 33.3 per cent (4,127 cars) from 1934 to 1935. The remaining increases of 94.6 per cent and 66.7 per cent were due to the reduction in turnaround time of freight cars in the respective periods. The breakdown of turnaround time of freight cars and the distribution of the increase of average daily carloadings from 1934 to 1935 are given in Tables A-9 and A-10.

TABLE A-9

AVERAGE DAILY CARLOADINGS AND BREAKDOWN OF TURNAROUND TIME OF FREIGHT CARS, 1934-35

	1934	1935	Difference
ADC (cars)	55,717	68,093	+12,376
Freight car turnaround (days)	8.75	7.69	−1.06
Active fleet of cars	487,524	523,635	+36,111
Total freight car turnaround (hrs.)	210.7	184.6	−26.1
Time in trains (hrs.)	72.5	63.3	−9.2
Time at technical stations (hrs.)	92.2	82.5	−9.7
Loading and unloading time (hrs.)	46.0	38.8	−7.2

SOURCE: *65*, 433.

TABLE A-10

BREAKDOWN OF INCREASE IN AVERAGE DAILY CARLOADINGS BY CAUSAL FACTORS, 1934-35

Total increase in ADC in 1935 (annual average)	12,376
Change in ADC produced by increase in the active fleet of freight cars	4,127
Change in ADC produced by decrease in turnaround time	8,249
Decrease of time in trains	2,907
Change in the detention time at technical stations	3,065
Change in the detention time in loading and unloading	2,275
Total increase in ADC (difference due to rounding)	12,374

SOURCE: Computed from Table A-9.

In considering the possible reasons for the above reduction in turnaround time of 1.06 days, we have to note first a decline of 42 kilometers in the average total freight car turnaround trip from 1934 to 1935, which explains in part the decrease in total turnaround time (by 26.1 hours), in part the reduction in detention time of freight cars at technical stations (by 9.7 hours), and in part the reduction in time spent in trains (by 9.2 hours) as explained above. Time spent in trains was decreased by the improvement in train speed coefficient (i.e., reduced demurrage of cars at way stations) and by some increase in the technical speed of trains. It was in 1936 and not in 1935 that the technical speed was increased by the upward revision of maximum boiler pressure norms for different locomotives. Table A-11 illustrates this point quite clearly.

TABLE A-11

TECHNICAL AND AVERAGE SECTION SPEEDS OF FREIGHT TRAINS, 1913, 1928-36

	Technical Speed	Average Section Speed	Train Speed Coefficient
1913	16.5	13.6	0.82
1928	21.1	14.1	0.67
1930	21.8	12.2	0.56
1932	23.0	14.3	0.62
1933	22.3	13.8	0.62
1934	23.5	14.2	0.60
1935	24.4	15.6	0.64
1936	29.8	18.3	0.61

SOURCE: Series C-18 and C-19 in Appendix C.

Analysis of railroad performance, supplemented by an analysis of capital investment in the form of new freight cars and locomotives, gives us a detailed picture of the events during the transportation crisis in 1933-34 and suggests some possible explanations for the improvements and the higher level of performance maintained in later years. Tables A-12 and A-13 show the extent to which the deliveries of new locomotives and new freight cars increased in this period. The cumulative effect of rolling stock deliveries before the peak in 1935 should also be taken into consideration in evaluating the full impact of these capital investments. The total carrying capacity of freight cars and the total tractive effort of locomotives increased more rapidly than the number of physical units because of the addition of more powerful locomotives and heavier freight cars to stocks. Comparing the production and deliveries of new freight cars to the increases in the active fleet, we can gain some insight into how much the latter had been understated (or possibly overstated) in the current statistical reporting of railroads. The active fleet is less inclusive than the fleet under railroad jurisdiction, which covers the following categories of freight cars: active fleet, bad-order cars, work train cars, storage and housing, special uses.

A direct comparison between the freight cars delivered and the annual increases in the fleet under railroad jurisdiction, presented in Table A-14, indicates that there is no pronounced tendency to understate either of the two fleets when an average rate of retirement of 2 per cent per year is assumed, except perhaps for 1935. On the contrary, in some years freight cars seem to come in from sources other than production and repair of bad-order cars, even if we take the annual rate of retirement as zero.

In order to take into account all the leakages and injections of freight cars, we should compare the production and retirements with the increases in the inventory fleet of cars, the most inclusive series. The inventory fleet covers, in addition to all the categories in the fleet under railroad jurisdiction, the freight cars in the ministry reserve leased to other ministries and organizations and the freight cars transferred to railroads under construction. However, in this case it might be more appropriate to take cars produced rather than cars delivered to railroads under the ministry jurisdiction. The comparison in Table A-15 shows less discrepancy between the increases in the inventory fleet and the annual output of freight cars than in the active fleet or the fleet under railroad jurisdiction.

TABLE A-12

NEW FREIGHT LOCOMOTIVES PRODUCED AND DELIVERED TO RAILROADS, 1927/28-40
(physical units)

	Total Number of Locomotives		*Freight Locomotives*		*Type E.*		*Type F.D.*		*Type S.O.*	
	Produced	Delivered	Produced	Delivered	Produced	Delivered	Produced	Delivered	Produced	Delivered
1927/28	479	458	308	308	308	308	—		—	
1928/29	575	548		408		408	—		—	
1929/30	625	587	564	587	564	587				
1931	810	812	810	812	809	811	1			
1932	827	829	679	681	678	680	1	1	—	
1933	930	907	748	725	727	704	21	21		
1934	1,210	1,066	942	844	758	659	226	181	3	
1935 (1st half)	n.a.	n.a.	n.a.	n.a.	359[a]		247	n.a.	n.a.	
1935	1,518	1,495	1,146	1,123	560		521	521	65	
1936	1,153	n.a.	784		55		664		318	
1937	1,171	n.a.					541		346	
1938	1,216	n.a.					485		406	
1940	917	n.a.								

[a] Type E.M. only.

SOURCE: *Produced:* 1927/28-35, *65*, 163; 1935 (1st half), *6*, 1935, No. 11, 11; 1936, *47*, 181; 1937, *3*, vol. 44, 239; 1938, *37*, 1/21/39; 1940, *35*, 46.

Delivered: 1927/28-31, *14*, 87; 1932-35, *65*, 46.

TABLE A-13

NEW FREIGHT CARS PRODUCED AND DELIVERED TO RAILROADS, 1927/28-38

	Produced, Industry Excl. Railroad Workshops	Delivered, Excl. Railroad Workshops	*Produced*			*Delivered*	
			Industry	Railroad Workshops	Total	Industry Only	Total
	(physical units)		(2-axle units)				
1927/28	7,871	9,550	10,612	1,537	12,149	12,268	13,805
1928/29	11,264	10,728	15,190	1,500	16,690	14,557	16,057
1929/30	13,884	11,858	19,427	1,500	20,927	17,329	18,829
1931 (special quarter)		3,275				4,724	
1931	14,439	12,889	21,175	2,146	23,321	17,698	19,844
1932	15,230	11,280	20,152	3,199	23,351	16,023	19,222
1933	12,989	11,647	18,126	814	18,940	16,413	17,227
1934	20,732	18,935	28,957	—	28,957	26,741	26,741
1935	69,638	69,270	85,875	—	85,675	85,294	85,294
1936	27,512	n.a.	67,200	n.a.	67,200		67,200
1937	29,900	n.a.	59,000	n.a.	59,000		59,000
1938	n.a.	n.a.	n.a.	n.a.	n.a.		n.a.

Source: *Produced:* 1927/28-35, *65*, 163; 1936, *47*, 81; 1937, *72*, 207.
Produced in RR shops: 1928/29-30, estimates; 1931, *14*, 88.
Delivered: 1927/28-31, *14*, 88; 1932-35, *65*, 434.

APPENDIX A

TABLE A-14

COMPARISON OF ANNUAL CHANGES IN STOCKS OF FREIGHT CARS WITH ANNUAL DELIVERIES OF NEW FREIGHT CARS TO RAILROADS, 1928-37
(thousand 2-axle units)

	Annual Change in Average Active Fleet of Freight Cars	Annual Change in Average Fleet of Freight Cars Under Railroad Jurisdiction	Estimated Annual Retirement of Freight Cars from Fleet Under Railroad Jurisdiction	Total Number of Freight Cars Accounted for in Fleet Under Railroad Jurisdiction	Total Number of Freight Cars Delivered to Railroads	Total Number of Freight Cars Unaccounted for in Fleet Under Railroad Jurisdiction
1928	26.5	8.2	9.4	17.6	13.8	+3.8
1929	51.9	35.2	9.9	45.1	16.1	+29.0
1930	39.0	12.7	10.1	22.8	18.8	+4.0
1931	40.0	22.2	10.6	32.8	19.8	+13.0
1932	7.9	16.4	10.9	27.3	19.2	+8.1
1933	9.5	9.6	11.1	20.7	17.2	+3.5
1934	2.7	9.8	11.3	21.1	26.7	−5.6
1935	36.2	39.4	12.1	51.5	85.3	−33.8
1936	60.5	70.0	13.5	83.5	67.2	+16.3
1937	42.8	48.6	14.5	63.1	59.0	+4.1

SOURCE: Table A-13 and series C-26 and C-27 in Appendix C.

TABLE A-15

COMPARISON OF ANNUAL CHANGES IN INVENTORY FLEET OF FREIGHT CARS WITH ANNUAL PRODUCTION OF NEW FREIGHT CARS, 1928-37
(thousand 2-axle units)

	Annual Change in Freight Cars in Inventory Fleet (1)	Estimated Annual Retirement of Freight Cars from Inventory Fleet (2)	Total Number of Freight Cars Accounted for in Inventory Fleet (3)	Total Number of Freight Cars Produced (4)	Total Number of Freight Cars Unaccounted for in Inventory Fleet (5)
1928	30.1	10.0	40.1	12.1	+28.0
1929	17.4	10.4	27.8	16.7	+11.1
1930	12.0	10.6	22.6	20.9	+1.7
1931	18.6	11.0	29.6	23.3	+6.3
1932	13.2	11.3	24.5	23.4	+1.1
1933	15.0	11.6	26.6	18.9	+7.7
1934	15.4	11.9	27.3	29.0	−1.7
1935	48.0	19.9	67.9	85.7	−17.8
1936	33.9	14.2	48.1	67.2	−19.1
1937	31.1	14.9	46.0	59.0	−13.0

SOURCE: Col. 1: 1928-29, 1932, 1937—Based on inventory freight car fleet in physical units (*29*, 201; *84*, 469) and percentage of 4-axle units in total inventory fleet (series C-28 in Appendix C); 1930-31, 1933—Based on fleet under railroad jurisdiction (series C-27 in Appendix C) and interpolated percentage it was of total; 1934—*34*, *7*; 1935-36—*47*, 121.

Col. 2: Estimated.

Col. 3: Col. 1 plus col. 2.

Col. 4: Table A-13.

Col. 5: Col. 3 minus col. 4.

The positive discrepancy (Table A-15, column 5) probably reflects in part an overstatement (and the negative discrepancy an understatement) in the assumed 2 per cent per annum rate of retirements, and in part deficiencies in basic statistical data on stocks.

Bearing in mind the implications of these findings, we shall continue our analysis of the 1933-34 transportation crisis. The data in Table A-15 permit us to make allowances in the active fleet of freight cars for the probable understatement of the increase in the active fleet in 1935. Subtracting the annual increase of 36,200 cars and the 2 per cent retirement of 10,500 cars in the active fleet from the number of cars delivered to railroads during 1935 (all in 2-axle units), we get a rough approximation of the number of cars in the actual active fleet that the railroads failed to report in their current statistics, i.e., 38,600 cars.

A direct comparison of the increase in the active fleet and the cars delivered to railroads (after allowance for retirements) might be justified for 1935. The backlog of unshipped freight and the high pressure put on railroads to increase average daily carloadings in 1933-35 make transfers of large numbers of freight cars from the active fleet (or the inclusion of newly produced and delivered cars) to other categories of the fleet under railroad jurisdiction highly improbable. This proposition is supported by the relatively insignificant discrepancy between the increments in the active fleet and the increase of only 32,000 cars in the fleet under railroad jurisdiction in 1935.

Adding 38,600 cars to the reported active fleet of 523,700, we obtain an adjusted active fleet of 562,300, which makes it possible to compute adjusted turnaround time and to distribute the increment in the average daily carloadings by causal factors. The results of these adjustments are given in Table A-16.

TABLE A-16

BREAKDOWN OF INCREASE IN AVERAGE DAILY CARLOADINGS IN 1935 BY CAUSAL FACTORS, BASED ON REVISED ACTIVE FLEET

(2-axle units)

	1934	1935	Difference
ADC (cars)	55,717	68,093	12,376
Freight car turnaround (days)	8.75	[8.26]	.49
Active fleet of freight cars	487,524	562,300	74,776
Change in ADC produced by the increase in the active fleet of freight cars (cars)			8,546
Change in ADC produced by the decrease in the turnaround time (cars)			3,830

The causal factors for the ADC increment, as presented in Table A-16, shifted in favor of the increment in the inventory fleet of freight cars rather than in favor of the reduction in turnaround time as shown in Table A-10, according to official Soviet statistics. This finding suggests the final answer to the question posed at the beginning of this appendix, namely whether the increases in railroad investments or the better utilization of the available rolling stock were primarily responsible for the sharp and sustained increase in the average daily carloadings and in the volume of freight traffic in 1935.

These findings should be considered as suggestions rather than as final conclusions. Further research is needed, especially to compare different categories of freight car stock with the production data to determine how much railroad performance is exaggerated in Soviet statistics, a problem of great importance, but not of primary interest here.

APPENDIX B

Soviet Maritime Freight Traffic Statistics

BY GEORGE NOVAK

REVISED AND EXTENDED BY HOLLAND HUNTER

Total Maritime Traffic Carried in Soviet Bottoms

Statistics on maritime traffic are less comprehensive and less accurate than those on river traffic and cannot compare in either respect with railroad statistics. Several assumptions and approximations have to be made to estimate the volume of traffic in ton-kilometers, to obtain the desired breakdowns, and to expand the series beyond the periods for which they are readily available.[1]

Soviet reporting of maritime traffic covers petty and grand cabotage, local traffic, and foreign trade traffic originated or terminated in Soviet ports, all carried in ships of the Ministry of the Maritime Fleet. It also includes freight carried in Soviet ships between foreign ports,[2] but excludes freight carried in foreign ships between Soviet ports as well as foreign trade carried in foreign ships originated or terminated in Soviet ports.

The absence of any detailed breakdowns into the above categories makes any attempt to estimate the approximate distribution of total maritime traffic after World War II extremely hazardous. Even in the 1920's and 1930's such data, especially on the average length of haul, were scarce. Estimating procedures are complicated by changes in coverage[3] and by radical changes in the distribution of traffic among the various categories. We gather from the available sources that sometime in the late 1930's the Soviet statistical agencies attempted to estimate a series for the total volume of maritime traffic in ton-kilometers that would be homogeneous in coverage over time. Through

[1] Similar problems also exist in other countries, particularly in the United States.

[2] *32*, 71.

[3] The Soviet maritime fleet is owned and operated by various state agencies, cooperatives, collective farms, and other organizations. The greater part of the fleet, however, is under the jurisdiction of the Ministry of Water Transportation. In 1936 this ministry owned and operated 14.3 per cent of all Soviet ships which carried 75.1 per cent of the total freight traffic and 80.2 per cent of the total passenger traffic. They also carried nine-tenths of all tons originated *(perevozki)* and three-fourths of all passengers in petty cabotage. The ministry ships are the only Soviet ships in intersea and foreign trade shipping (*82*, 1937, No. 11, 10).

1934, maritime statistical authorities compiled ton-kilometers series, not as a sum of products of tons originated within a calendar year multiplied by the corresponding length of haul, but rather as a sum of products of tons terminated within a calendar year multiplied

TABLE B-1

TOTAL MARITIME TRAFFIC CARRIED IN SOVIET BOTTOMS, 1928-35

	By Origination (1)	By "Terminated Trips" (2)	Col. 2 as % of Col. 1 (3)
	A. MILLION METRIC TON-KILOMETERS		
1928	10,100	9,100	[90.0]
1929	10,400	9,390	90.3
1930	13,200	10,110	76.6
1931	16,000	14,672	91.7
1932	20,100	18,190	90.5
1933	24,400	23,424	96.0
1934	27,600	26,363	95.5
1935	34,100	33,219	97.4
	B. THOUSAND METRIC TONS ORIGINATED		
1928	8,300	7,900	[95.2]
1929	9,100	8,548	93.9
1930	12,400	11,264	90.8
1931	15,000	13,887	92.6
1932	15,100	14,828	98.2
1933	16,200	15,871	98.0
1934	22,600	21,687	96.0
1935	26,100	24,947	95.6
	C. AVERAGE LENGTH OF HAUL (KILOMETERS)		
1928	1,217	1,152	94.7
1929	1,143	1,098	96.1
1930	1,065	898	84.3
1931	1,067	1,056	99.0
1932	1,321	1,230	93.1
1933	1,506	1,478	98.1
1934	1,221	1,215	99.5
1935	1,307	1,332	101.9

SOURCE

Col. A-1, 1928: Col. A-2 divided by col. A-3.
Col. B-1, 1928: Col. B-2 divided by col. B-3.
Cols. A-1, B-1, 1929-35: *82*, 1940, No. 9, 3.
Cols. A-2, B-2, 1928: *66*, 40. Converted from nautical miles.
Cols. A-2, B-2, 1929-35: *42*, 8.
Cols. A-3, B-3, 1928: Estimated.
Col. C-1, 1928-35: Col. A-1 divided by col. B-1.
Col. C-2, 1928-35: Col. A-2 divided by col. B-2.

by the corresponding length of haul.[4] The shift from the second method to the first raised the series somewhat as a result of a continuous upward trend in the series (for any given year there were more tons originated than received). This can be seen from Table B-1.

From a theoretical point of view, it might be considered preferable to use the ton-kilometer series based on "terminated trips" rather than the one based on traffic originated within a given year. The errors of adjustment and other difficulties, however, make it more expedient to use the series based on tons originated currently reported by Soviet statistical agencies.[5]

The above ton-kilometer series represents total maritime traffic carried in Soviet bottoms (petty and grand cabotage and local transport, as well as foreign trade traffic). Though tons originated are readily available for all these categories through 1935, ton-kilometers can be obtained only for a few years. The year 1935 appears to be the only exception when ton-kilometers and the average length of haul are available for most of the categories and breakdowns. Therefore we have to estimate the other years by various methods.

It might be appropriate to consider first the total and domestic traffic carried in Soviet bottoms and then to devote some attention to the theoretically most desirable coverage, namely domestic maritime traffic carried in bottoms of all flags.

Foreign and Domestic Maritime Traffic Carried in Soviet Bottoms

THE INTERWAR PERIOD (1913, 1928-40)

Each of the two major series mentioned above ("by origination" and "by terminated trips") is broken down into four categories: petty cabotage, grand cabotage, foreign trade,[6] and local (domestic) traffic. The latter category represents the difference between the total traffic carried in Soviet bottoms and traffic carried by the so-called "transpor-

[4] Soviet sources use two similar concepts: "tons terminated" *(po pribytiiu)* and "completed trips" *(po zakonchenym reisam)*. There is, at least in principle, some difference between the two concepts: the former refers to tons, the latter to trips. Furthermore, the sources do not state explicitly whether the second concept refers to tons originated or to tons terminated for "terminated trips." It probably refers to the latter.

[5] Soviet statistical agencies continue to compile both series: "by origination" and "by completed trips." An editorial (*40*, 1951, No. 6, 1) explicitly gives the fulfillment of the 1950 Plan (102.1 per cent in tons and 105.5 per cent in ton-miles) for "terminated trips." It is possible that some of the reported percentage increases after World War II refer to "terminated trips," some to "tons originated," or to a combination of the two (for base and terminal years).

[6] Traffic carried in Soviet bottoms between foreign ports seems to be included in the total and is reported separately for selected years (see *42*, 6).

tation fleet," i.e., the fleet under the Ministry of Water Transportation.[7] Domestic maritime traffic includes three categories: petty cabotage, grand cabotage, and local traffic. Petty cabotage is supposed to include maritime traffic originated and terminated between the

TABLE B-2

DOMESTIC MARITIME TRAFFIC CARRIED IN SOVIET SHIPS, 1929-35

	By Origination				*By "Terminated Trips"*			
	Petty (1)	Grand (2)	Local (3)	Total (4)	Petty (5)	Grand (6)	Local (7)	Total (8)
				A. MILLION METRIC TON-KILOMETERS				
1929	n.a.	n.a.	n.a.	n.a.	4,278	1,330	n.a.	5,608
1930	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1931	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1932	n.a.	n.a.	n.a.	n.a.	7,282	4,682	n.a.	11,964
1933	n.a.	n.a.	n.a.	n.a.	8,210	5,782	n.a.	13,992
1934	n.a.	n.a.	50	n.a.	11,455	2,122	n.a.	13,577
1935	13,455	1,580	102	15,137	12,490	1,382	n.a.	13,872
				B. THOUSAND METRIC TONS ORIGINATED				
1929	7,357	119	n.a.	n.a.	7,277	100	n.a.	7,377
1930	10,337	224	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1931	12,665	231	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1932	12,696	415	n.a.	n.a.	12,927	380	n.a.	13,307
1933	12,989	264	261	13,514	13,139	352	n.a.	13,491
1934	18,523	228	402	19,153	18,162	211	n.a.	18,373
1935	20,057	122	747	20,926	19,969	114	n.a.	20,083
				C. AVERAGE LENGTH OF HAUL (KILOMETERS)				
1929	n.a.	n.a.	n.a.	n.a.	587	13,329	n.a.	760
1930	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1931	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1932	n.a.	n.a.	n.a.	1,035	563	12,305	n.a.	899
1933	n.a.	n.a.	n.a.	n.a.	124	16,420	n.a.	1,037
1934	n.a.	n.a.	124	n.a.	632	10,016	n.a.	739
1935	671	12,951	137	723	626	12,079	n.a.	691

SOURCE

Cols. A-1, A-2, A-3, B-1, B-2, B-3: *42*, 6.

Cols. A-5, A-6, B-5, B-6, C-5, C-6: *65*, 480.

Cols. A-7, B-7, C-7: "Terminated trips" were reported for the "transportation fleet" only, i.e., excluding local traffic. Therefore, no estimates of local traffic have been attempted here.

Cols. C-1, C-2, C-3, C-4, C-8: Cols. A-1, A-2, A-3, A-4, and A-8 divided by cols. B-1, B-2, B-3, B-4, and B-8.

Col. C-4, 1932: *28*, 20.

NOTE: Nautical miles and nautical ton-miles in the original sources have been multiplied by 1.852 to convert them into kilometers and ton-kilometers.

[7] The local maritime traffic series has a relatively short average length of haul (124 kms in 1934 and 137 kms in 1935) and appears in all breakdowns of Soviet maritime shipping agencies for 1935, except for the Baltic and Sochi State Maritime Steamship Agency (compare breakdowns in *42*, 198-202).

ports of the same sea. However, an average length of haul exceeding 10,000 kilometers and the tiny volume of tonnage originated (about 2 per cent of the total) cast some doubts on this official Soviet definition of grand and petty cabotage. The traffic between the Black and Azov Seas, as well as that between different seas of the Arctic Ocean, is probably classified as petty cabotage. The problem of estimating the breakdown of total maritime traffic between petty and grand cabotage, as well as local traffic, is indicated in Table B-2.

Inspecting the average length of haul in part C of Table B-2, we find an upward bias in the series by origination in 1935. The ratio of the origination series to that for "terminated trips" in that year was 1.072 for both petty and grand cabotage. Applying these ratios to the average length of haul for "terminating trips" (Table B-2, cols. C-5 and C-6), we may estimate the average length of haul by origination (Table B-3).

TABLE B-3

ESTIMATED AVERAGE LENGTH OF HAUL, DOMESTIC MARITIME TRAFFIC, 1913, 1928-35
(kilometers)

	By Origination			*By "Terminated Trips"*		
	Petty (1)	Grand (2)	Local (3)	Petty (4)	Grand (5)	Local (6)
1913	[600]	[13,186]	n.a.	[560]	[12,300]	n.a.
1928	[622]	[13,936]	[100]	[580]	[13,000]	n.a.
1929	629	14,289	[100]	587	13,329	n.a.
1930	[621]	[13,922]	[105]	[579]	[12,987]	n.a.
1931	[612]	[13,557]	[110]	[571]	[12,646]	n.a.
1932	604	13,191	[115]	563	12,305	n.a.
1933	669	17,602	120	624	16,420	n.a.
1934	678	10,737	124	632	10,016	n.a.
1935	671	12,951	137	626	12,079	n.a.

SOURCE

Col. 1, 1913, 1928-34: Based on col. 4 and ratio of col. 1 to col. 4 in 1935.

Col. 2, 1913, 1928-34: Based on col. 5 and ratio of col. 1 to col. 5 in 1935.

Cols. 1 and 2, 1935, col. 3, 1933-35: Table B-2.

Col. 3, 1928-32: Assumed.

Cols. 4 and 5, 1913: Estimated from 1932 ALH since the distribution of tons originated between petty and grand cabotage in 1913 most closely approached that of 1932.

Cols. 4 and 5, 1928: Extrapolated.

Cols. 4 and 5, 1929, 1932-35: *65*, 480.

Cols. 4 and 5, 1930-31: Interpolated.

The volume of local traffic originated can be taken as the difference between the two series given in Table B-4.

TABLE B-4

LOCAL MARITIME TRAFFIC, 1913, 1928-35
(thousand tons originated)

	Total Maritime Traffic Carried in Soviet Bottoms		
	Including Local Traffic (1)	Excluding Local Traffic (2)	Local Traffic (3)
1913	n.a.	n.a.	n.a.
1928	n.a.	n.a.	[200]
1929	9,100	8,839	261
1930	12,400	12,278	122
1931	15,000	14,627	373
1932	15,100	14,820	280
1933	16,200	16,129	261
1934	22,600	22,587	402
1935	26,100	26,102	747

SOURCE

Col. 1, 1929-35: *82*, 1940, No. 9, 3.
Col. 2, 1929-35, col. 3, 1933-35: *42*, 6.
Col. 3, 1923: Assumed.
Col. 3, 1929-32: Col. 1 minus col. 2.

Combining the available data with the above estimates, we obtain the total volume of domestic maritime traffic carried in Soviet bottoms (Tables B-5, B-6, B-7, and B-8).

TABLE B-5

PETTY CABOTAGE MARITIME TRAFFIC CARRIED IN SOVIET BOTTOMS, 1913, 1928-35

	Tons Originated (thousands) (1)	ALH (kilometers) (2)	Ton-Kilometers (millions) (3)
1913	11,332	[600]	[6,799]
1928	6,602	[622]	[4,106]
1929	7,357	629	4,628
1930	10,337	[621]	[6,419]
1931	12,665	[612]	[7,751]
1932	12,696	604	7,668
1933	12,989	669	8,690
1934	18,523	678	12,559
1935	20,057	671	13,455

SOURCE

Col. 1, 1913, 1929-35: *42*, 6.
Col. 1, 1928: *38*, vol. 107, 3f.
Col. 2, 1913, 1928-35: Table B-3.
Col. 3, 1913, 1928-34: Col. 1 times col. 2.
Col. 3, 1935: *42*, 6.

APPENDIX B

TABLE B-6

GRAND CABOTAGE MARITIME TRAFFIC CARRIED IN SOVIET BOTTOMS, 1913, 1928-35

	Tons Originated (thousands) (1)	ALH (kilometers) (2)	Ton-Kilometers (millions) (3)
1913	571	[13,186]	[7,529]
1928	130	[13,936]	[1,812]
1929	119	14,289	1,700
1930	224	[13,922]	[3,119]
1931	231	[13,557]	[3,132]
1932	415	13,191	5,474
1933	264	17,602	4,647
1934	228	10,737	2,448
1935	122	12,951	1,580

SOURCE

Col. 1, 1913, 1928-35: *42*, 6.
Col. 1, 1928: *38*, vol. 107, 3.
Col. 2, 1913, 1928-35: Table B-3.
Col. 3, 1913, 1928-34: Col. 1 times col. 2.
Col. 3, 1935: *42*, 6.

TABLE B-7

LOCAL MARITIME TRAFFIC CARRIED IN SOVIET BOTTOMS, 1913, 1928-35

	Tons Originated (thousands) (1)	ALH (kilometers) (2)	Ton-Kilometers (millions) (3)
1913	n.a.	n.a.	n.a.
1928	[200]	[100]	[20]
1929	261	[100]	[26]
1930	122	[105]	[13]
1931	373	[110]	[41]
1932	280	[115]	[32]
1933	261	120	31
1934	402	124	50
1935	747	137	102

SOURCE

Col. 1: Table B-4.
Col. 2: Table B-3.
Col. 3: Col. 1 times col. 2.

A comparison of the ALH for 1932 (984 kms) estimated by the above method and the given ALH (1,035 kms) [8] suggests that the above estimates are understated. An upward revision of the ALH by 5.2 per cent would raise the estimates to those shown in Table B-9.

[8] *28*, 20.

APPENDIX B

TABLE B-8

DOMESTIC MARITIME TRAFFIC CARRIED IN SOVIET BOTTOMS, 1913, 1928-35

	Tons Originated (thousands) (1)	ALH (kilometers) (2)	Ton-Kilometers (millions) (3)
1913	11,903	[1,204]	[14,328]
1928	[6,932]	[857]	[5,938]
1929	7,737	821	6,354
1930	10,683	[894]	[9,551]
1931	13,269	[823]	[10,924]
1932	13,391	984	13,174
1933	13,514	989	13,368
1934	19,153	786	15,057
1935	20,926	723	15,137

SOURCE

Cols. 1 and 3: Sum of Tables B-5, B-6, and B-7.
Col. 2: Col. 3 divided by col. 1.

TABLE B-9

ADJUSTED DOMESTIC MARITIME TRAFFIC CARRIED IN SOVIET BOTTOMS, 1913, 1928-35

	Tons Originated (thousands) (1)	ALH (kilometers) (2)	Ton-Kilometers (millions) (3)
1913	11,903	[1,267]	[15,081]
1928	[6,932]	[900]	[6,239]
1929	7,737	862	6,669
1930	10,683	[939]	[10,031]
1931	13,269	[864]	[11,464]
1932	13,391a	1,034.5	13,853b
1933	13,514	1,004	13,568
1934	19,153	798	15,284
1935	20,926	723	15,137

a A rounded alternative figure of 13.3 million tons originated is given in *28*, 20.
b A rounded alternative figure of 13.8 billion ton-kilometers is given in *28*, 20.

SOURCE

Col. 1, 1913, 1928-35: Table B-8.
Col. 2, 1913, 1928-31: ALH in Table B-8 times 1.052.
Col. 2, 1932: *28*, 20.
Col. 2, 1933: ALH in Table B-8 times 1.03.
Col. 2, 1934: ALH in Table B-8 times 1.015.
Cols. 2 and 3, 1935: Table B-8.
Col. 3, 1913, 1928-34: Col. 1 times col. 2.

An alternative method of estimating total maritime traffic would be to take the ratio of total ton-kilometers, including foreign trade, by origination to that by "terminated trips" given in Table B-1, and apply it to estimated domestic ton-kilometers "by terminated trips." However, neither this nor the ratio between the average length of

hauls was stable enough over the period to make such a procedure seem preferable to developing a domestic ton-kilometers series based on tons originated.

THE PERIOD SINCE WORLD WAR II

The official Soviet series for maritime freight traffic since World War II covers all Soviet movements, including those to and from non-Soviet ports, but only those in Soviet vessels. No attempt is made here to estimate the volume of traffic between Soviet ports carried in foreign ships. However, data have been released that enable us to estimate domestic maritime traffic, which is done in the following paragraphs. The procedure involves ignoring the local and grand cabotage components of domestic maritime traffic, in the absence of evidence, and concentrating on the petty cabotage component, which in any case makes up the bulk of the category we are interested in.

The transportation handbook (*70,* 100) supplies data in tons for dry freight in petty cabotage, by year, for 1946-56. To this must be added "timber and firewood in rafts" (available in *ibid.,* 97), and tanker freight. Unfortunately the series for tanker freight covers grand cabotage and foreign traffic as well as petty cabotage. Nevertheless geography can aid us. Most petty cabotage tanker freight is petroleum moving on the Caspian Sea; these shipments far outweigh the movements from Batumi to Odessa on the Black Sea, and other coastwise movements in the Black Sea, Baltic Sea, far northern waters, or the Sakhalin area. The handbook gives data (*ibid.,* 107) for tons originated of petroleum and petroleum products, by republic, for 1950 and 1955; Caspian Sea traffic involves the Azerbaidzhan SSR and the Turkmen SSR. Adding these two together accounts for 63.9 per cent of total USSR maritime petroleum-and-petroleum-product tons originated in 1950, and 52.6 per cent of them in 1955. The tonnage involved was 10.1 million in 1950 and 12.1 in 1955, while total USSR oil originations rose from 15.8 to 23.0 million tons. Estimates for Caspian Sea oil originations during the intervening years of 1951-54 can be inserted roughly in proportion to year-to-year trends in the national total (which changed very little from 1953 to 1954).

For the period from 1945 to 1950, an additional clue can be employed, by assuming that the rise in Caspian Sea oil originations was proportionate to the rise in crude oil production in Azerbaidzhan and the Turkmen SSR (available in *53,* 155). On this assumption, 1945 Caspian Sea oil originations were 64.6 per cent of national

maritime oil originations, as compared to 63.9 per cent in 1950. For the intervening years, 1946-49, one can let this ratio decline evenly and estimate the Caspian Sea figures from the national figures for maritime oil originations. Similarly, for 1956 one can assume that Caspian Sea oil originations rose over 1955 in the same proportion that Azerbaidzhan and Turkmen crude oil production rose in 1956 over 1955 (see *45,* 209). The result of these computations is a continuous series, 1945-56, for estimated petty cabotage tanker originations, which can be combined with the published series for dry and rafted freight to get total petty cabotage maritime tons originated.

The average length of haul for petty cabotage maritime shipments in 1945 was 800 kilometers (given as 799 in *29,* 13), and by 1955 it had fallen 15 per cent, to 680 kilometers (*10,* 132). For the intervening years, 1946-54, an assumption that the average haul fell evenly cannot depart seriously from the facts. We are therefore able to construct Table B-10, dividing total postwar maritime freight traffic into its petty cabotage and "other" components (where "other" includes grand cabotage and local traffic as well as foreign traffic).

TABLE B-10

SOVIET MARITIME FREIGHT TRAFFIC, TOTAL, PETTY CABOTAGE, AND OTHER, 1945-59

	Tons Originated (millions)			*Ton-Kilometers* (billions)			*Average Haul* (kilometers)		
	Total	Petty	Other	Total	Petty	Other	Total	Petty	Other
1945	20.2	10.9	9.3	34.3	8.7	25.6	1,698	800	2,753
1946	20.3	11.0	9.3	29.5	8.7	20.8	1,453	790	2,237
1947	24.3	13.9	10.4	34.8	10.8	24.0	1,432	780	2,308
1948	26.9	14.8	12.1	34.8	11.4	23.4	1,294	770	1,934
1949	30.9	18.5	12.4	37.2	14.1	23.1	1,204	760	1,863
1950	33.7	21.1	12.6	39.7	15.8	23.9	1,179	750	1,897
1951	36.5	24.0	12.5	40.4	17.8	22.6	1,107	740	1,808
1952	41.2	27.4	13.8	44.3	19.9	24.4	1,075	725	1,768
1953	45.5	29.6	15.9	48.2	21.0	27.2	1,053	710	1,711
1954	48.5	31.1	17.4	56.7	21.6	35.1	1,169	695	2,017
1955	53.7	34.0	19.7	68.9	23.1	45.8	1,284	680	2,325
1956	57.7	36.5	21.2	82.4	24.8	57.6	1,430	680	2,717
1957	65.7			92.7			1,411		
1958	70.8			106.3			1,503		
1959	73.5			115.7			1,574		

SOURCE: Total traffic, from series C-44, C-45, and C-46. Estimates for petty cabotage traffic, explained above. Data for "other" traffic, residuals.

These estimates for petty cabotage traffic understate the volume of domestic maritime traffic in two respects. A portion of the petty

cabotage petroleum traffic escapes measurement, and grand cabotage traffic, together with local traffic, remains in the "other" category. Local traffic before the war was small, and may be presumed to cause minor error. Though the volume of grand cabotage traffic appears also to be small, its average haul in 1955 was "over 16,000 kilometers" (*10*, 132), and therefore even 100,000 tons originated would involve 1.6 billion ton-kilometers of "domestic" traffic excluded from our estimates. Petty cabotage petroleum traffic outside the Caspian Sea may also involve appreciable additional ton-kilometers that should be counted.

Nevertheless, these estimates serve to bring out clearly the divergent trends in domestic and foreign maritime traffic that are masked in the total traffic series. Domestic traffic rose steadily after 1946, in accordance with traffic carried by other carriers and the internal performance of the economy. Foreign traffic, on the other hand, remained generally constant in volume through 1952, and only since Stalin's death has it risen rapidly. The indicated trend accords well with Soviet foreign trade data, and conforms with much other evidence. It will be noted that the average haul for "other" traffic fell from 1945 to 1953, when Soviet policy was "isolationist," and has risen since then (at least through 1956), as the USSR extended its economic relations with the outside world. In spite of the recognized underestimation of domestic traffic associated with the petty cabotage series above, its year-to-year trend is surely a closer indication of the true record than the mixed aggregate represented by the official Soviet series for total maritime traffic.

APPENDIX C

Basic Series on Soviet Transportation

BY GEORGE NOVAK

REVISED AND EXTENDED BY HOLLAND HUNTER

General Note

Most of these data were assembled in the mid-1950's from primary Soviet sources published during the 1920's and 1930's. Since 1956 many series have been republished and extended in new statistical publications, the most important for transportation being the USSR Central Statistical Administration's *Transport i sviaz'* [Transportation and Communications in the USSR] published in 1957. The new figures generally correspond to those released contemporaneously, and absolute data now available for postwar years generally fall very close to our previous estimates derived from indirect percentage or other relationships.

In all series below, the newly available Soviet figures are given in column 1, with alternative figures given in column 2 only where significant discrepancies appear.

The series cover the Soviet territory as it existed in the given years. For 1913, they cover the pre-World War II territory; and for 1940, the post-World War II territory. At the head of the stub there is a special entry, 1913A, which refers to Tsarist territory for 1913 excluding Finland.

A dash (—) means that there was no production or that it was negligibly small. A blank space means that no definite information was found. Estimates and adjustments of other types are indicated by square brackets. A single asterisk (*) indicates that the figure refers to the calendar year in which the fiscal year given in the stub ended. A double asterisk (**) indicates that the figure refers to the fiscal year ending in the calendar year given in the stub.

I. Railroad Freight Traffic[a]

	C-1 Tariff Ton-Kilometers (billions)		C-2 Tons Originated	C-3 Average Length of Haul (kilometers)	
	(1)	(2)		(1)	(2)
1913A	76.8	76.0	158.2	485	
1913	65.7		132.4	496	
1914	62.9	74.7	122.9	512	
1915	75.6	83.1	126.1	600	
1916	91.2		147.4	619	
1917	63.0	63.0	115.2	547	
1918	14.1	14.2	37.2	381	380
1919	17.5	17.5	30.5	574	
1920	14.4	13.5	40.3	357	
1921	15.7		37.4	415	399
1921/22	16.1		39.9	402	
1922/23	23.5		58.0	405	407
1923/24	33.7		67.5	500	
1924/25	47.4		83.5	568	
1925/26	68.9		116.7	590	500
1926/27	81.7		135.9	601	
1928	93.4		156.2	598	
1929	113.0		187.6	602	612
1930	133.9		238.7	561	
1931	152.1		258.3	589	
1932	169.3		267.9	632	
1933	169.5		268.1	632	635
1934	205.7		317.1	649	669
1935	258.1		388.5	664	
1936	323.4		483.2	669	
1937	354.8		517.3	686	
1938	370.5		516.3	718	
1939	391.7		553.6	708	
1940	415.0		592.6	700	705
1941	[402]		[549]	732	[693]
1942	[228]		[290]	786	
1943	[256]		313.0	[818]	
1944	[297]		371.0	[801]	
1945	314.0		395.2	794	
1946	335.0		452.6	740	745
1947	350.5		491.1	714	709
1948	446.0		619.8	720	
1949	523.8		735.3	712	728
1950	602.3		834.3	722	727
1951	677.3		909.2	745	
1952	741.3		997.0	744	749
1953	798.0		1,067.4	748	752
1954	856.8		1,131.4	757	762
1955	970.9		1,267.0	766	771
1956	1,079.1		1,371.0	787	
1957	1,212.8		1,487.7	815	
1958	1,302.0		1,616.9	805	
1959	1,429.5		1,763.8	810	
1960	1,504.3		1,884.9	798	

[a] Excluding company material hauled in nonrevenue trains.

	C-4 Average Daily Carloadings (thous. 2-axle units)	C-5 Average Load per Car (metric tons)	C-6 *Operating Ton-Kilometers* (billions) (1)	Excess of Operating over Tariff Ton-Kms (per cent) (2)	(3)
1913A	33.0	13.1			
1913	27.4	13.2	[67.7]	[3.0]	
1914					
1915					
1916					
1917	25.8	12.7			
1918	[8.90]	[11.5]			
1919	7.91	10.3			
1920	10.7	9.87			
1921	10.2	10.2			
1921/22	9.59	11.5			
1922/23	11.7	13.6			
1923/24	13.5	13.7			
1924/25	17.4	13.1			
1925/26	24.0	13.3			
1926/27	27.9	13.4			
1928	32.3	13.2	95.4	2.15	
1929	38.6	13.3	117.5	4.03	
1930	46.3	14.1	142.6	6.46	6.5
1931	49.3	14.3	164.0	7.81	8.0
1932	51.4	14.3	177.1	4.60	5.0
1933	51.2	14.3	176.7	4.25	5.0
1934	55.7	15.6	217.4	5.67	5.7
1935	68.1	15.6	268.8	4.14	4.2
1936	86.2	15.4	332.5	2.82	3.3
1937	89.8	15.8	367.8	3.65	3.7
1938	88.0	16.1	384.4	3.75	3.8
1939	93.4	16.2	404.6	3.3	3.3
1940	97.9	16.6	432.5	4.2	4.6
1941	[86.0]	[17.4]	[419.0]	[4.3]	
1942	42.8	[18.6]	[238]	[4.4]	
1943	45.7	18.8	[269]	5.2	
1944	55.7	18.3	[321]	7.99	
1945	62.2	17.5	348.8	11.1	8.0
1946	69.8	17.8	[361.0]	[7.7]	
1947	75.7	17.9	365.2	4.2	
1948	90.3	18.8	[461.2]	[3.4]	
1949	104.7	19.2	[537.4]	[2.6]	
1950	118.1	19.3	613.7	1.9	
1951	127.5	19.5	[689.5]	[1.8]	
1952	138.2	19.8	[753.9]	[1.7]	
1953	147.6	19.8	810.8	1.6	
1954	156.5	19.8	867.9	1.3	
1955	169.3	20.5	980.0	1.1	
1956	[181.5]	[20.7]	1,093.8	1.4	
1957	[195.0]	[20.9]	1,230.1	1.4	
1958	[209.9]	[21.1]	1,319.4	1.3	
1959	[226.9]	[21.3]	1,452.4	1.6	
1960	[240.2]	[21.5]	1,536.4	2.1	

C-7
Commodity Composition, Tons Originated (millions)

Commodity	1930 (1)	1935 (2)	1940 (3)	1945 (4)	1950 (5)	1955 (6)	1958 (7)	1960 (8)
Coal and coke	41.4	94.7	152.5	142.3	266.1	389.0	478.8	492.5
Building timber	30.9	42.2	42.8	26.5	72.4	94.1	121.5	140.7
Oil and oil products	13.2	22.4	29.5	21.3	43.2	77.6	112.5	151.0
Mineral building materials	—	61.2	111.7	41.9	157.5	245.6	324.2	430.4
Iron and steel	8.3	19.1	27.1	21.3	43.3	71.8	88.3	106.4
Grain	24.3	30.0	44.6	20.2	38.8	58.0	71.5	78.8
Ores	9.9	26.0	35.2	17.8	48.4	83.8	108.1	127.4
Firewood	15.1	18.3	23.1	17.4	18.9	16.4	18.1	19.7
All other	—	74.7	126.1	86.6	145.7	230.7	293.9	338.0

C-8
Commodity Composition, Ton-Kilometers (billions)

Coal and coke	25.4	61.0	106.9	98.7	178.2	266.7	348.9	333.8
Building timber	20.3	33.8	43.6	20.7	72.2	119.9	178.4	213.6
Oil and oil products	10.4	22.8	36.4	23.8	52.0	101.6	154.0	205.4
Mineral building materials	—	—	28.2	9.6	46.7	82.1	113.9	155.6
Iron and steel	6.7	18.7	26.2	23.9	47.5	75.7	90.6	110.4
Grain	14.6	20.6	32.8	23.3	30.9	55.1	80.8	90.7
Ores	3.9	16.0	21.5	12.5	27.8	45.0	59.9	71.6
Firewood	3.8	4.7	5.8	2.7	4.5	5.2	6.8	8.2
All other	—	—	113.6	98.8	142.5	219.6	268.7	315.0

	C-9 Total Passenger-Kilometers (billions)	C-10 Total Passengers (millions)	C-11 Average Length of Total Trip (kilometers)	C-12 Long-Distance Passenger-Kilometers (billions)
1913A	29.7	244.3	122	27.8
1913	25.2	184.8	136	23.7
1914		234.8		
1915		264.4		
1916		347.9		
1917		353.5		
1918		385.5		
1919		201.6		
1920		142.6		
1921	11.3	83.6	136	
1921/22	9.87	76.6	129	
1922/23	13.9	121.8	114	
1923/24	15.4	154.4	100	13.3
1924/25	19.0	211.8	90	16.4
1925/26	23.4	262.7	89	20.2
1926/27	22.1	254.2	87	18.9
1928	24.5	291.1	84	20.6
1929	32.0	365.2	88	27.4
1930	51.8	557.7	93	44.3
1931	61.8	723.7	85	50.2
1932	83.7	967.1	87	67.0
1933	75.2	927.0	81	59.1
1934	71.4	945.2	76	54.6
1935	67.9	919.1	74	51.1
1936	77.2	991.6	78	59.3
1937	90.9	1,142.7	80	69.5
1938	84.9	1,173.2	72	69.4
1939	93.7	1,267.2	74	[69.2]
1940	98.0	1,343.5	73	73.2
1941				
1942				
1943				
1944				
1945	65.9	843.0	78	50.9
1946	97.9	1,078.1	91	
1947	95.1	1,094.7	87	
1948	82.5	1,049.3	79	
1949	81.3	1,080.1	75	61.4
1950	88.0	1,163.8	76	66.8
1951	98.5	1,315.3	75	73.4
1952	107.4	1,440.7	75	79.6
1953	118.3	1,504.3	79	89.4
1954	129.1	1,573.6	82	98.5
1955	141.4	1,641.4	86	109.1
1956	142.4	1,658.3	86	109.9
1957	153.4	1,754	87	118.7
1958	158.4	1,834	86	121.6
1959	164.4	1,883	87	126.0
1960	170.8	1,950	88	130.1

II. Railroad Passenger Traffic (concluded)

	C-13 Long-Distance Passengers (millions)	C-14 Average Length of Long-Distance Trip (kilometers)	C-15 Suburban Passenger-Kilometers (billions)	C-16 Suburban Passengers (millions)	C-17 Average Length of Suburban Trip (kilometers)
1913A	169.4	164	1.91	74.9	26
1913	125.5	189	1.54	59.3	26
1914					
1915					
1916					
1917					
1918					
1919					
1920					
1921					
1921/22					
1922/23					
1923/24	74.3	180	2.08	80.1	26
1924/25	105.5	155	2.68	106.3	25
1925/26	131.9	153	3.21	130.8	25
1926/27	122.4	154	3.24	131.8	25
1928	134.1	154	3.84	157.0	24
1929	173.4	158	4.61	191.8	24
1930	240.5	184	7.43	317.2	24
1931	245.9	204	11.6	477.8	24
1932	303.1	221	16.7	664.0	25
1933	297.6	199	16.0	629.4	25
1934	258.3	211	16.9	686.9	25
1935	228.1	224	16.8	691.0	24
1936	249.0	238	17.9	742.6	24
1937	273.4	254	21.4	869.3	25
1938	272.6	255	22.3	905.2	25
1939	286.2	[242]	[24.5]	980.9	[25]
1940	340.4	215	24.7	1,003	24.6
1941					
1942					
1943					
1944					
1945	254.0	200	15.0	590	25.4
1946					
1947					
1948					
1949	202.5	303	19.9	877.6	22.7
1950	209.1	319	21.2	954.7	22.2
1951	214.3	343	25.1	1,101	22.8
1952	222.7	357	27.8	1,218	22.8
1953	229.3	390	28.9	1,275	22.7
1954	235.6	418	30.6	1,338	22.9
1955	249.4	437	32.3	1,392	23.2
1956	244.3	450	32.5	1,414	23.0
1957	248.0	479	34.7	1,506	23.0
1958	251.0	484	36.8	1,583	23.2
1959	248.0	508	38.4	1,635	23.5
1960	237.0	549	40.7	1,713	23.8

III. Freight Train Performance

	C-18 Average Section ("Commercial") Speed (kms-hr.)	C-19 Average "Technical" Speed (kms-hr.)	C-20 Average Gross Train Weight (metric tons)	C-21 Average Net Train Weight (metric tons)	C-22 Total Train-Kilometers (millions)
1913A				302	244.7
1913	13.6	16.5	573	[302]	211.9
1914				269	
1915				279	
1916					
1917	13.1				
1918	13.0				
1919	12.5			162	
1920	12.2			196	
1921	12.7			209	
1921/22	12.3			228	65.1
1922/23	13.3	18.3		272	81.4
1923/24	13.5	20.4		320	101.7
1924/25	13.2	20.6	740	371	124.2
1925/26	13.2	20.9	765	395	170.6
1926/27	13.3	20.9	818	411	194.9
1928	14.1	21.1	817	420	218.8
1929	13.3	21.1	854	443	252.5
1930	12.2	21.8	937	523	266.9
1931	13.2	22.3	967	549	293.0
1932	14.3	23.0	966	543	320.3
1933	13.8	22.3	959	533	326.4
1934	14.2	23.5	994	556	386.2
1935	15.6	24.4	1,035	590	450.0
1936	18.3	29.8	1,160	661	503
1937	19.5	31.4	1,199	677	543.3
1938	19.1	31.9	1,262	[703]	[546.8]
1939	19.3	32.7	1,296	711	569.1
1940	20.3	33.0	1,298	726	595.7
1941			[1,315]		
1942					
1943					
1944					
1945	17.2	29.2	1,249	686	508.5
1946	17.9		1,221	[670]	[538.8]
1947	18.9	32.9	1,238	[687]	[531.6]
1948	17.4		[1,340]	[750]	[614.9]
1949	18.4		[1,390]	[785]	[684.6]
1950	20.1	33.8	1,430	815	753.0
1951	22.0	34.5	1,478	839	[821.8]
1952	23.3	34.9	1,521	859	[877.6]
1953	23.5	35.0	1,579	894	906.9
1954	22.9	35.2	1,660	936	927.2
1955	24.7	37.1	1,758	1,002	978.0
1956	24.8	37.6	1,831	1,052	1,039.7
1957	25.6	37.8	1,887	1,089	1,129.6
1958	26.6	38.5	1,972	1,126	1,171.7
1959	27.2	39.2	2,037	1,167	1,244.6
1960	28.3	40.4	2,099	1,201	1,279.3

	C-23 Locomotives in Inventory Fleet (thousands)	C-24 Total Tractive Effort of Locomotives in Inventory Fleet (th. m. tons)	C-25 *Average Daily Kilometers per Locomotive-Day (kilometers)*			
			All (1)	Steam (2)	Electric (3)	Diesel (4)
1913A	20.0	204.3	119.1			
1913	17.0	174.0	119.1			
1914						
1915						
1916						
1917			91.5			
1918			58.6			
1919			67.9			
1920			59.5			
1921			84.2			
1921/22	19.1		90.5			
1922/23	19.5		107.0			
1923/24	20.2		114.6			
1924/25	20.3		120.5			
1925/26	19.3		122.0			
1926/27	18.5		130.9			
1928	16.5	186.0	137.5			
1929	[16.6]	[192.6]	151.5			
1930	[17.0]	[204.0]	153.3			
1931	[18.6]	[230.6]	159.7			
1932	19.2	246.6	164.6			
1933	[20.2]	[262.6]	163.5			
1934	[21.0]	[279.3]	168.5			
1935	22.1	306.5	189.1			
1936	23.0	323.8	232.3			
1937	23.6	337.5	245.6			
1938	[24.3]	[355.4]	250.8			
1939	25.0	373.2	251.2			
1940	[28.0]	[418.5]	255.1			
1941						
1942	[23.8]					
1943	[25.8]					
1944	[26.4]					
1945	[27.0]	[430]	215	213	307	376
1946						
1947						
1948			214			
1949			232			
1950	[31]	[520]	245	243	302	300
1951			250	247	313	286
1952			252	250	302	284
1953	34.0	[600]	256	253	306	291
1954	35.0		257	253	312	294
1955	36.0	[640]	286	277	382	362
1956			296	282	428	388
1957			317	299	457	427
1958			328	302	497	447
1959			345	309	535	470
1960			367	317	557	486

	C-26 Active Fleet, Revenue Trains (th. car-days per day in 2-axle units)	C-27 Fleet Under RR Jurisdiction (th. car-days per day in 2-axle units)	C-28 Percentage of Four-Axle Units in Total Inventory Fleet	C-29 Turnaround Time, Active Fleet (days) (1)	C-29 Turnaround Time, Active Fleet (hours) (2)
1913A	397.6	470.4			
1913	336.2	397.2		12.27	294.5
1914					
1915					
1916					
1917	238.1				
1918	212.9				
1919	184.9				
1920	257.9	[410.1]			
1921	218.5	[417.1]		21.5**	516.0**
1921/22	218.7	407.0		22.8	547.2
1922/23	200.8	391.9		17.1	410.4
1923/24	216.3	423.5		16.0	384.0
1924/25	233.1	433.5		13.4	321.6
1925/26	300.1	436.4		12.5	300.0
1926/27	314.9	450.3		11.3	271.2
1928	341.4	472.0	5.5	10.56	253.4
1929	393.3	494.5	[6.2]	10.19	244.6
1930	432.8	507.2	6.9	9.34	224.2
1931	472.8	529.4	[7.6]	9.58	229.9
1932	480.7	545.8	8.3	9.35	224.4
1933	490.2	555.4	9.0	9.57	229.4
1934	487.5	565.2	10.5	8.75	210.7
1935	523.7	604.6	12.1	7.69	184.6
1936	580.7	[670.6]	15.6	6.74	162.8
1937	627.0	723.2	19.6	6.98	167.5
1938	662.1	757.4	22.7	7.52	180.5
1939	677.0	[780.0]	24.9	7.25	174.0
1940	721.2	836.7	30	7.37	176.9
1941	[726]			8.44	202.6
1942	590	669		13.8	331.2
1943	576	725		12.6	302.4
1944	[655]	[820]		[11.7]	[281.3]
1945	674	[838]	[28]	10.84	260.2
1946	699		28	9.99	239.8
1947	731			9.65	231.6
1948	788			8.73	209.5
1949	866			8.19	196.6
1950	885	[1,028]	[36.4]	7.49	179.8
1951	909			7.13	171.1
1952	949			6.87	164.9
1953	980			6.64	159.4
1954	1,045		53.4	6.68	160.3
1955	1,055	[1,230]*	[55]	6.23	149.5
1956	[1,145]			6.31	151.4
1957	[1,193]			6.12	146.9
1958	[1,224]		70.5	5.83	139.9
1959	[1,298]			5.72	137.3
1960	[1,343]			5.59	134.2

	C-30 Average Daily Kilometers per Active Car-Day (kilometers)	C-31 Average Total Turnaround Trip (kilometers)	C-32 Average Loaded Turn-around Trip (kilometers)	C-33 *Average Empty Turnaround Trip*	
				(kilometers) (1)	Per Cent of Total Trip (2)
1913A	75.0	904	645	259	
1913	[75.0]	920	[657]	263	28.6
1914					
1915					
1916					
1917	65.8				
1918	27.9				
1919	35.9				
1920	34.8				
1921	37.9**	815**	505**	310	38.0**
1921/22	37.9	864	550	314	36.3
1922/23	48.0	821	522	299	36.4
1923/24	56.3	901	582	319	35.4
1924/25	67.0	898	634	264	29.4
1925/26	72.9	911	650	261	28.6
1926/27	80.4	909	647	262	28.8
1928	84.6	892	637	255	28.6
1929	87.3	890	642	248	27.9
1930	89.5	836	611	225	26.9
1931	90.9	871	644	227	26.1
1932	97.3	910	664	246	27.0
1933	97.6	934	673	261	27.9
1934	117.5	1,029	732	297	28.9
1935	128.4	987	719	268	27.2
1936	140.3	946	692	254	26.9
1937	139.8	976	721	255	26.1
1938	138.4	1,041	753	288	26.8
1939	145.2	1,053	757	296	28.1
1940	139.9	1,032	732	300	29.1
1941	130.3	1,100	806	294	26.7
1942	94.6	1,305	920	385	29.5
1943	108.2	1,363	924	439	32.2
1944	[109.0]	1,275	877	398	31.2
1945	123.5	1,339	979	360	26.9
1946	120.5	1,204	873	331	27.5
1947	111.6	1,077	767	311	28.8
1948	123.8	1,081	784	297	27.5
1949	133.9	1,097	792	305	27.8
1950	146.4	1,097	801	296	27.0
1951	159.0	1,073	781	292	27.2
1952	165.2	1,135	818	317	27.9
1953	171.8	1,141	825	316	27.7
1954	173.3	1,158	838	320	27.6
1955	188.2	1,172	844	328	28.0
1956	191.2	1,206	868	338	28.0
1957	206.4	1,263	[902]	[361]	[28.6]
1958	216.5	1,262	893	369	29.2
1959	222.5	1,271	902	369	29.0
1960	227.0	1,269	908	361	28.4

	C-34 Total Road Operated, Annual Averages (th. kms)	C-35 Total Road Operated, End of Year (th. kms)	C-36 Freight Traffic Density (th. ton-kms per km of road operated)	C-37 Passenger Traffic Density (th. ton-kms per km of road operated)
1913A	70.5	71.7	1,089	421
1913	58.5	58.5	1,122	431
1914	67.6	[62.3]		
1915	64.0	[65.1]		
1916	55.3	[69.3]		
1917	63.3	70.3	997	
1918	26.8	[71.3]	528	
1919	31.5	[71.4]	556	
1920	56.8	71.6	253	
1921	66.5	71.8	236	170
1921/22	69.4	71.9	231	142
1922/23	69.6	72.3	338	200
1923/24	73.9	74.5	457	209
1924/25	74.4	74.5	638	256
1925/26	74.6	75.7	924	313
1926/27	75.7	76.9	1,078	292
1928	76.9	76.9	1,215	318
1929	77.0	76.9	1,467	416
1930	77.1	77.9	1,738	672
1931	80.2	81.0	1,896	770
1932	81.6	81.8	2,075	1,027
1933	82.1	82.6	2,065	916
1934	83.2	83.5	2,472	858
1935	83.8	84.4	3,079	811
1936	85.1	85.1	3,801	907
1937	84.9	84.9	4,179	1,071
1938	84.9	85.0	4,362	1,079
1939	85.7	86.4	4,570	1,094
1940	95.5	106.1	4,346	1,018
1941				
1942		62.9		
1943	72.3	81.7	3,540	
1944	96.2	110.7	3,090	
1945	111.8	112.9	2,809	589
1946	113.5	114.1	2,952	863
1947	114.8	115.5	3,053	828
1948	115.7	115.8	3,855	713
1949	115.9	116.0	4,519	701
1950	116.5	116.9	5,170	755
1951	117.3	117.8	5,774	840
1952	118.2	118.6	6,272	909
1953	119.3	119.9	6,689	992
1954	120.1	120.3	7,134	1,075
1955	120.5	120.7	8,057	1,173
1956	120.7	120.7	8,940	1,180
1957	121.0	121.2	10,023	1,268
1958	122.0	122.8	10,672	1,298
1959	123.6	124.4	11,566	1,330
1960	125.1	125.8	12,025	1,365

	C-38 *Composite Passenger Ton-Kilometers*		C-39 *Labor Productivity*		
	Passenger Tariff Ton-Kms	Passenger Operating Ton-Kms in Revenue Trains	Based on Composite Tariff Ton-Kms	Based on Composite Operating Ton-Kms in Revenue Trains	C-40 Operating Labor Force
	(billions)		(th. compos. passenger ton-kms per operating worker)		(th. workers)
	(1)	(2)	(1)	(2)	
1913A	106.5		130.6		823
1913	90.9	[92.9]	132.9	[134]	691
1914					
1915					
1916					
1917					
1918					
1919					
1920					
1921	27.0				
1921/22	25.9				
1922/23	37.5				
1923/24	49.2				
1924/25	66.5				
1925/26	92.3		106.2		869
1926/27	103.8		113.9		911
1928	117.9	119.9	136.6	138.9	863
1929	144.9	149.5	167.0	172.2	868
1930	185.7	194.4	195.3	204.4	951
1931	213.9	225.8	195.6	206.4	1,094
1932	253.0	260.8	240.1	247.4	1,054
1933	244.6	251.9	239.6	246.7	1,021
1934	277.2	288.8	241.4	251.6	1,148
1935	326.0	336.7	261.0	269.6	1,249
1936	400.6	409.7	329.4	336.9	1,216
1937	445.8	458.7	356.6	367.0	1,250
1938	462.2	469.3	353.4	358.8	1,308
1939	485.4	498.3	[369.1]	[381.3]	[1,307]
1940	513.0	530.5	368.0	380.6	1,394
1941					
1942					
1943					
1944					
1945	379.9	414.7	250.3	273.9	1,514
1946	432.9	[458.9]	274.3	[290.8]	1,578
1947	445.6	460.3	282.3	291.0	1,580
1948	528.5	[543.7]	327.5	[341.7]	1,591
1949	605.1	[618.7]	365.2	[373.4]	1,657
1950	690.3	701.7	403.2	409.9	1,712
1951	775.8	[788.0]	439.5	[446.5]	1,765
1952	848.7	[861.3]	454.8	[461.5]	1,866
1953	916.3	929.1	482.0	488.7	1,901
1954	985.9	997.0	501.0	506.6	1,968
1955	1,112.3	1,121.4	561.8	566.4	1,980
1956	1,221.5	1,236.2	616.9	624.3	1,980
1957	1,336.2	1,383.5	669.8	693.5	1,995
1958	1,460.4	1,477.8	731.3	740.0	1,997
1959	1,593.9	1,616.8	799.3	810.8	1,994
1960	1,675.1	1,707.2	833.0	848.9	2,011

	C-41 *Ton-Kilometers*		C-42 *Tons Originated*		C-43 *Average Length of Haul*	
	Under Ministry (billions)	Under Ministry and Other Organizations (billions)	Under Ministry (millions)	Under Ministry and Other Organizations (millions)	Under Ministry (kilometers)	Under Ministry and Other Organizations (kilometers)
	(1)	(2)	(1)	(2)	(1)	(2)
1913A						
1913	26.2	30.9	34	34.3	771	901
1914						
1915						
1916						
1917						
1918						
1919						
1920						
1921						
1921/22						
1922/23		10.5*		14.6*		715*
1923/24	7.52*	8.80*	9.26*	13.5*	812*	652*
1924/25	10.6*	12.0*	12.6*	17.2*	840*	700*
1925/26	12.9*	15.5*	16.2*	21.7*	797*	714*
1926/27	14.2*	16.5*	16.9*	23.4*	844*	706*
1928	15.9	17.5	18.3	25.5	867	687
1929	18.4	20.7	23.2	32.0	794	646
1930	22.9		36.6	41.1	625	
1931	27.0		44.8		603	
1932	25.1		47.0		534	
1933	25.8		44.7		578	
1934	29.0		52.7		550	
1935	33.9		64.7		524	
1936	31.1		69.9		446	
1937	33.0		66.9		494	
1938	32.0		66.6		481	
1939	34.6		73		474	
1940	35.8	35.9	72.3	72.9	495	492
1941						
1942						
1943						
1944						
1945	18.3	18.6	36.1	36.6	507	509
1946	19.9	20.4	38.9	39.9	512	511
1947	24.4	25.1	46.1	48.2	530	520
1948	30.9	32.1	59.9	63.5	516	506
1949	37.2	38.8	72.6	78.0	512	497
1950	45.5	45.9	85.5	91.5	532	502
1951	51	51.5	96.6	102.8	528	501
1952	57.1	57.8	104	109.8	549	527
1953	58.6	58.9	107.4	116.1	546	507
1954	61.7	62.4	120.3	128.2	513	486
1955	66.6	67.4	129.3	139.1	515	484
1956		70.5		147.1		480
1957		76.4		159.2		480
1958		85.5		178.3		480
1959		93.6		192.2		488
1960		99.6		210.3		474

IX. Maritime Freight Traffic Carried in Soviet Bottoms

	C-44 *Total Ton-Kilometers* (billions)		C-45 *Total Tons Originated* (millions)			C-46 Average Length of Total Haul (kilometers)
		For Terminated Trips		For Terminated Trips		
	(1)	(2)	(1)	(2)	(3)	
1913A	[23.6]		14.7			[1,605]
1913	[22.2]		13.9			[1,593]
1914						
1915						
1916						
1917						
1918						
1919						
1920			2.87			
1921			3.49			
1921/22			3.71*			
1922/23			4.08*			
1923/24			3.98*			
1924/25			5.26*			
1925/26			6.03*			
1926/27			6.92*			
1928	[10.1]	9.10	8.30		7.85	[1,217]
1929	10.4	9.39	9.10	8.84	8.55	1,143
1930	13.2	10.1	12.4	12.3	11.3	1,065
1931	16.0	14.7	15	14.6	13.9	1,067
1932	20.1	18.2	15.1	14.8	14.8	1,331
1933	24.4	23.4	16.2	15.9	15.9	1,506
1934	27.6	26.4	22.6	22.2	21.7	1,221
1935	34.1	33.2	26.1	25.4	25.0	1,307
1936	41.1		30.6		28.6	1,343
1937	36.4		29.4			1,238
1938	33.9		30.3			1,119
1939	[29.8]		[30.2]			[987]
1940	23.1		31			745
1941						
1942						
1943						
1944						
1945	34.2		20.2			1,698
1946	29.4		20.3			1,453
1947	34.8		24.3			1,432
1948	34.8		26.9			1,294
1949	37.2		30.9			1,204
1950	39.7		33.7			1,179
1951	40.3		36.5			1,107
1952	44.3		41.2			1,075
1953	48.2		45.5			1,053
1954	56.6		48.5			1,169
1955	68.9		53.7			1,284
1956	82.4		57.7			1,430
1957	92.7		65.7			1,411
1958	106.3		70.8			1,503
1959	115.7		73.5			1,574
1960	131.5		75.9			1,733

IX. MARITIME FREIGHT TRAFFIC CARRIED IN SOVIET BOTTOMS (concluded)

	C-47 Domestic Ton-Kilometers (billions)	C-48 Domestic Tons Originated (millions) (1)	(2)	C-49 Average Length of Domestic Haul (kilometers)
1913A	[15.8]	12.5		[1,267]
1913	[15.1]	11.9		[1,269]
1914				
1915				
1916				
1917				
1918				
1919				
1920				
1921				
1921/22				
1922/23				
1923/24			3.30*	
1924/25			4.38*	
1925/26			5.19*	
1926/27			5.96*	
1928	[6.24]	[6.93]	6.73	[900]
1929	[6.67]	[7.74]	7.42	[862]
1930	[10.0]	[10.7]	10.6	[939]
1931	[11.5]	[13.3]	12.9	[864]
1932	[13.9]	[13.3]	13.1	1,035
1933	[13.6]	13.5	13.2	[1,004]
1934	[15.3]	19.1	18.7	[798]
1935	15.1	20.9	20.2	723
1936	16.7	24.8		672
1937	17	24.3		702
1938	18.8	[26.6]		[706]
1939	23.0	28		821
1940	21.6	30.3		714
1941				
1942				
1943				
1944				
1945	[10.1]	[12.6]		799
1946	[12.4]	[15.5]		[802]
1947	[14.7]	[18.6]		[790]
1948	[16.6]	[21.3]		[779]
1949	[19.6]	[25.4]		[772]
1950	[21.2]	[27.9]		[760]
1951	[22.9]	[30.5]		[751]
1952	[25.8]	[34.8]		[741]
1953	[28]	[38.3]		[731]
1954	[28.2]	[39.1]		[721]
1955				
1956				
1957				
1958				
1959				
1960				

X. Oil Pipeline Traffic

	C-50 Ton-Kilometers (millions)	C-51 Tons Originated (thousands)	C-52 Average Length of Haul (kilometers)
1913A			
1913	[327]	370	883
1914			
1915			
1916			
1917			
1918			
1919			
1920			
1921	79**	89**	883**
1921/22	155	176	883
1922/23	103	117	883
1923/24	348	394	883
1924/25	403	582	692
1925/26	388	627	619
1926/27	536	990	541
1928	683**	1,108**	616**
1929	1,131**	1,619**	699**
1930	2,232	3,997	558
1931	2,624	4,423	593
1932	2,863	5,077	564
1933	3,380	5,808	582
1934	3,504	6,580	532
1935	[3,500]	4,800	[529]
1936	[3,600]	6,900	[514]
1937	3,600	7,500	480
1938	[3,600]		
1939	[3,700]		
1940	3,800	7,900	481
1941			
1942			
1943			
1944			
1945	2,700	5,600	482
1946	3,600		
1947			
1948			
1949			
1950	4,900	15,300	320
1951	5,500	18,400	299
1952	6,400	23,200	276
1953	7,600	29,400	259
1954	10,200	39,700	257
1955	14,700	51,700	284
1956	20,500	65,300	314
1957	26,600	80,900	329
1958	33,800	94,900	356
1959	41,600	111,300	374
1960	51,200	129,900	394

	C-53 Ton-Kilometers (billions)	C-54 Tons Originated (millions)	C-55 Average Length of Haul (kilometers)
1913A			
1913	0.1	10.0	10.0
1914			
1915			
1916			
1917	0.1	10.0	10.0
1918			
1919			
1920	0.1	10.0	10.0
1921			
1921/22			
1922/23			
1923/24	0.2	15.0	10.3
1924/25	0.2	16.0	10.3
1925/26	0.2	17.0	10.2
1926/27	0.2	18.0	10.1
1928	0.2	20.0	10.0
1929	0.3	29.0	10.4
1930	0.5	48.0	10.4
1931	0.8	76.0	10.5
1932	1.1	100.0	10.7
1933	1.3	130.0	10.0
1934	2.4	233.0	10.3
1935	3.5	343.1	10.2
1936	5.5	539.2	10.2
1937	5.9	569.1	10.4
1938	6.8	642.7	10.5
1939	7.9	826.8	9.6
1940	8.9	858.6	10.4
1941			
1942			
1943			
1944			
1945	5.0	420.0	12.0
1946	7.5	610.0	12.3
1947	10.6	803.5	13.2
1948	13.3	1,092.4	12.2
1949	17.0	1,481.3	11.5
1950	20.1	1,859.2	10.8
1951	24.1	2,252.3	10.7
1952	27.6	2,652.8	10.4
1953	31.4	3,002.7	10.4
1954	37.5	3,305.9	11.4
1955	42.5	3,730.0	11.4
1956	48.5	4,200.9	11.5
1957	61.7	5,216.4	11.8
1958	76.8	6,474.4	11.9
1959	87.6	7,398.6	11.8
1960	98.5	8,492.7	11.6

APPENDIX C

Sources

I. Railroad Freight Traffic

C-1 *Tariff ton-kilometers*

Col. 1	1913A, 1913	*38*, vol. 104, 2. See notes.
	1914-16	*24*, 6. See notes.
	1917-21	*64*, 258. See notes.
	1921/22-26/27	*14*, 20 f.
	1928-40, 1945-56	*70*, 32. For 1929, another source (*14*, 20 f) gives 112.9 bill. ton-kms.
	1941	Traffic in first half of 1941 is stated (*86*, 15) to be 90% of amount planned for first half of 1942 (510 bill. ton-kms, *72*, 450). Second half of 1941 interpolated between first half of 1941 and first half of 1942, which is taken to be half of 1942.
	1942-44	Based on total traffic (*gruzooborot*) in 1942-44 (which is stated to be 3.4 times 1915-17 traffic, *13*, 3/16/46) and annual relatives for 1943 (113% given for operating ton-kms, *90*, 1944, No. 10-11, 18, adjusted to 112.1% since excess of operating over tariff ton-kms increased between 1942 and 1943) and 1944 (116%, *43*, 200).
	1957-58	*45*, 545.
	1959	*67*, 168.
	1960	*46a*, 531.
Col. 2	1913A, 1914-15, 1917-20	*38*, vol. 3, 14 ff. Given in pood-versts. See notes.

This series, like C-2, C-3, C-4, C-5, and C-6, covers all railroad freight traffic except company material hauled in nonrevenue trains. The 1913 figure is adjusted by Bureau of Railroad Administration downward to cover USSR territory and upward to include company material hauled in revenue trains. The figures for 1914-16 cover slow speed railroad freight traffic, excluding company material but including military traffic, on the territory of the Russian Empire. They are a rough approximation of the figures adjusted to cover USSR territory and to include company material in revenue trains, since the company material in revenue trains in 1913 about equaled traffic in the Western territories ceded in 1918. The coverage of the figures for 1917-20 varies with the changing territory during the civil war. According to *38*, vol. 3, 8, the railroads were requested, in 1921, to fill out a special form giving the data for the preceding four years. Since only about half of all the railroads were able to supply any information and even much of this was fragmentary, the data are incomplete and inaccurate.

C-2	*Tons originated*	
	1913A, 1913	*38,* vol. 104, 2. See notes to series C-1.
	1914-16	*24,* 6. Rough estimates, according to *59,* 48. For coverage, see notes to series C-1.
	1917-21	*64,* 258. Incomplete data. See notes to series C-1.
	1921/22-26/27	*14,* 20 f.
	1928-40, 1945-56	*70,* 32.
	1941-42	Ton-kms (series C-1) divided by ALH (series C-3).
	1943	Based on 1944 traffic and announced annual relative (118.3%, *43,* 200).
	1944	ADC (series C-4) times ALC (series C-5) times 365.
	1957-58	*45,* 545.
	1959	*67,* 169.
	1960	*46a,* 537.
C-3	*Average length of haul (ALH)*	
Col. 1	1913A, 1913	*38,* vol. 104, 2.
	1914-16, 1918, 1921, 1922/23, 1928-40, 1943-49	Ton-kms (series C-1) divided by tons originated (series C-2). For coverage for 1914-16, see notes to series C-1.
	1917, 1919-20	*64,* 258. See notes to series C-1.
	1921/22, 1923/24-26/27	*14,* 20 f.
	1941	*69,* 1945, No. 7-8, 11.
	1942	ALH in 1942 is stated (*43,* 192) to be 86 kms longer than in 1940.
	1950-56	*70,* 34.
	1957-58	*45,* 545.
	1959	*46,* 495.
	1960	*46a,* 537.
Col. 2	1918, 1921, 1922/23, 1925/26	*64,* 258. For 1922/23, also *14,* 20 f.
	1929	*14,* 21. Given for 1928, which appears to be a misprint for 1929.
	1933-34	*27,* 23.
	1940-41	*90,* 1946, No. 10, 39. For 1941, for first half of year only.
	1946-47	*30,* 26.
	1949	ALH in 1949 is stated (*81,* 106) to be 104% of 1940.
	1950, 1954-55	*90,* 1956, No. 4, 40.
	1952-53	*48,* 1954, No. 6, 52.
C-4	*Average daily carloadings (ADC)*	
	1913A, 1913	*38,* vol. 104, 2. Computed by Bureau of Railroad Administration from assumed ALC of 800 poods. See notes.

1917, 1919-21	*38,* vol. 2, 34 f; vol. 8, 162 f. Sum of freight and tank cars counted by axles.
1918, 1956-60	Tons originated (series C-2) divided by estimated ALC (series C-5) divided by 365. For 1918, *38,* vol. 2, 34 f, gives 5.95 thous., which was not used since it gives a load per car of 17.12 tons which is unrealistically high.
1921/22-1933	*14,* 16. See notes.
1934-39	*26,* 60. For 1934-35, also *65,* 424; and for 1936-39, also *28,* 56.
1940	*28,* 56.
1941	Estimated tons originated (series C-2) divided by estimated ALC (series C-5) divided by 365. *90,* 1947, No. 11, 8, gives 107 thous. for first half of 1941.
1942-44	Based on 1945 ADC and announced annual relatives for 1943-45 (106.8% and 121.8% for 1943 and 1944, *90,* 1947, No. 11, 9; and 111.6% for 1945, *13,* 2/6/46).
1945	ADC in 1946 are stated (*88,* 21) to be 7,630 more than in 1945.
1946-49	Based on 1950 ADC and announced annual relatives for 1947-50 (108.5% for 1947, *43,* 217; 119.3% for 1948, *51,* 1/20/49; 116% for 1949, *18,* 1/18/50; and 112.8% for 1950, *13,* 4/17/51).
1950	ADC in 1950 are stated (*44,* 28 f) to be 121% of ADC in 1940 and 431% of ADC in 1913.
1951-52	ADC in 1951 and 1952 are stated (*44,* 28 f) to be 108% and 117%, respectively, of ADC in 1950.
1953	ADC in 1953 are stated (*44,* 28 f) to be 125% of ADC in 1950.
1954-55	ADC in 1954 and 1955 are stated (*44,* 28 f) to be 571% and 618% of ADC in 1913, 160% and 173% of ADC in 1940, and 132% and 143% of ADC in 1950.

Official prerevolutionary railroad statistics did not include ADC for the network as a whole. Therefore all figures before 1917 are based either on an assumed load per car or on reports from individual railroads. The figure of 27,400 is given for 1913 in all official Soviet statistics but it appears to be understated in light of an unofficial figure of 58,000 (*33,* 642) and the official Russian data on the avg. dynamic load per car of 10.7 tons. See also notes to series C-5.

For 1921/22-33, reporting is based on all cars loaded (*zaniato*) including double counting of cars reloaded (e.g., from bad-order cars on the line,

reclassification of freight, etc.). ADC reported after Jan. 20, 1934, exclude all such technical reloadings and are based on cars loaded with new freight received by railroads. The exclusion of double counting resulted in understatement of ADC estimated to be 1-2% (*14*, 115, 16).

For 1945-55, narrow-gauge, West European gauge, and South Sakhalin railroads are not included (*29*, 41).

C-5 *Average load per car (ALC)*

1913A, 1913, 1917, 1919-40, 1942-43, 1946-55	Tons originated (series C-2) divided by ADC (series C-4) divided by 365.
1918	Interpolated.
1941	Estimated tons originated (series C-2) divided by ADC of 107 thous. (*90*, 1947, No. 11, 8, given for first half of 1941) divided by 365.
1944-45	*90*, 1946, No. 1, 68, and No. 7, 23.
1956-60	Arbitrarily extrapolated.

Official Soviet statistics assumed an ALC of 800 poods (*64*, 256 f) though it could have been computed directly from available statistical data. The assumed ALC appears to be too high and also distorts other indexes derived from it. Using our computed figure, the ADC are raised to 33,067 for the USSR territory and to 39,510 for the Russian Empire territory. This would also affect the turnaround time of freight cars, decreasing it to 10.17 days.

The ALC reported by Soviet statistics (*64*, 256 f, and *29*, 20) appears to be based on tons terminated rather than on tons originated.

C-6 *Operating ton-kilometers*

Col. 1	1913, 1928-29, 1939-41, 1943-44, 1946, 1948-54	Tariff ton-kms (series C-1) plus excess of operating over tariff ton-kms (derived from col. 2).
	1945	*78*, 45.
	1947	Based on statement (*79*, 31) that productivity on Kishinev and Omsk railroads in 1947 was 113 and 865 th. m. tons per operating worker, respectively, or 38.8% and 296% of the network average, respectively, and operating labor force (series C-40).
	1930-33	*14*, 21.
	1934-35	*74*, 278.
	1936	*47*, 122.
	1937	*72*, 222.
	1938	*13*, 3/9/39.
	1942	Based on 1943 operating ton-kms and announced annual relative (113%, *90*, 1944, No. 10-11, 18).
	1955-60	*90*, 1961, No. 10, 4.

Col. 2	1913, 1928-29	Extrapolated.
	1930-38, 1942, 1945, 1947, 1956-60	Operating ton-kms (col. 1) minus tariff ton-kms (series C-1). For 1933-36, *63*, 1937, No. 6, 55, gives 4.5%, 5.4%, 4.0%, and 2.8%, respectively.
	1939	*68*, 1955, vol. XI, 427.
	1940	*28*, 237.
	1941, 1946, 1948-49, 1951-52	Interpolated.
	1943-44	*2*, 61.
	1950, 1954-55	*4*, 68.
	1953	*90*, 1955, No. 11, 53.
Col. 3	1930-39, 1945	*68*, 1955, vol. XI, 427 and 46.
	1940	*2*, 61.

C-7 *Commodity composition, tons originated*

Col. 1	*14*, 26 f.
Col. 2	*65*, 420 ff. For mineral building materials, see *114*, 303.
Cols. 3, 5-7	*45*, 548 f.
Col. 4	*114*, 347. For rounded data, see *70*, 35 ff.
Col. 8	*46a*, 537.

C-8 *Commodity composition, ton-kilometers*

Col. 1	*14*, 26 f.
Col. 2	*65*, 420 ff.
Cols. 3, 5-7	*45*, 546 f.
Col. 4	*114*, 347. For rounded data, see *70*, 35 ff.
Col. 8	*46a*, 536.

II. Railroad Passenger Traffic

C-9 *Total passenger-kilometers*

1913A, 1913, 1921-22/23	*38*, vol. 104, 4; vol. 17, 4 f; vol. 36, 16.
1923/24-26/27	*14*, 36 f.
1928-40, 1945-56	*70*, 32. For 1938, *2*, 77, gives 91.7 bill.
1957-58	*45*, 552.
1959	*67*, 170.
1960	*46a*, 538.

C-10 *Total passengers*

1913A, 1913, 1921	*38*, vol. 104, 4; vol. 8, 194. For 1913, *59*, 279, gives 238.6 mill.
1914-16	*3*, vol. 24, 764. *59*, 279, gives 269, 298.8, and 350.4 mill.
1917-20	*59*, 209.
1921/22-26/27	*14*, 36 f.
1928-40, 1945-56	*70*, 32. For 1938, *2*, 77, gives 1, 177.8 mill.
1957-58	*45*, 552.
1959	*67*, 171.
1960	*46a*, 538.

C-11	*Average length of trip*	
	1913A, 1913, 1922/23	*38,* vol. 104, 4; vol. 36, 16.
	1921-21/22, 1938-39, 1946-49, 1957-60	Passenger-kms (series C-9) divided by no. of passengers (series C-10).
	1923/24-33	*14,* 36 f.
	1934-35	*65,* 427.
	1936-37	*84,* 365.
	1940, 1949	*29,* 68.
	1945, 1950-56	*70,* 42.
C-12	*Long-distance passenger-kilometers*	
	1913A, 1913	*38,* vol. 104, 4.
	1923/24-33	*14,* 36 f.
	1934-35	*65,* 427.
	1936-38	*84,* 365.
	1939, 1945, 1949-50, 1952-60	Total passenger-kms (series C-9) minus suburban passenger-kms (series C-15).
	1940	*88,* 469.
	1951	*29,* 70.
C-13	*Long-distance passengers*	
	1913A, 1913	*38,* vol. 104, 4.
	1923/24-33	*14,* 36 f.
	1934-35	*65,* 427.
	1936-40	*88,* 496.
	1945, 1949-50, 1952-60	Total no. of passengers (series C-10) minus no. of suburban passengers (series C-16).
	1951	*29,* 70.
C-14	*Average length of long-distance trip*	
	1913, 1913A	*38,* vol. 104, 4.
	1923/24-30, 1933, 1935, 1939, 1945, 1949-60	Long-distance passenger-kms (series C-12) divided by no. of long-distance passengers (series C-13).
	1931	*29,* 70.
	1932, 1934	*84,* 365.
	1936-38, 1940	*11,* 303.
C-15	*Suburban passenger-kilometers*	
	1913A, 1913	*38,* vol. 104, 4.
	1923/24-33	*14,* 36 f.
	1934-35	*65,* 427.
	1936-38	*84,* 365.
	1939	No. of suburban passengers (series C-16) times estimated avg. length of suburban trip (series C-17).
	1940	*88,* 469. *10,* 248, gives 27.7 bill.
	1945, 1950-56	*70,* 41.
	1949	*68,* vol. 13, 401.

1957-58	*45*, 552.
1959	*46*, 495.
1960	*46a*, 538.

C-16 Suburban passengers

1913A, 1913	*38*, vol. 104, 4.
1923/24-33	*14*, 36 f.
1934-35	*65*, 427.
1936	*84*, 365.
1937-40	*2*, 77. For 1939, *88*, 496, and *11*, 250, give 981.1 mill.
1945, 1950-56	*70*, 41.
1949	*68*, vol. 13, 401.
1957-58	*45*, 552.
1959	*46*, 495.
1960	*46a*, 538.

C-17 Average length of suburban trip

1913A, 1913	*38*, vol. 104, 4.
1923/24-33	*14*, 36 f.
1934-35	*65*, 427.
1936-38	*84*, 365.
1939	Interpolated.
1940	*88*, 497.
1945, 1949-60	Suburban passenger-kms (series C-15) divided by no. of suburban passengers (series C-16).

III. Freight Train Performance

C-18 Average section ("commercial") speed

1913	*12*, 10.
1917-21/22	*38*, vol. 2, 39; vol. 7, 108; vol. 36, 18.
1922/23-33	*14*, 56.
1934-37	*25*, 300.
1938	*63*, 1939, No. 6, 25.
1939	*23*, 132. Also, *48*, 1939, No. 8, 165.
1940	*44*, 177. Also, *12*, 10.
1945	*88*, 384.
1946	"Commercial" speed is stated (*61*, 3) to have increased 6.8 kms between 1945 (interpreted as 1946) and 1955.
1947	"Commercial" speed is stated (*76*, 108) to have increased more than 20% in the last 12 years.
1948	"Commercial" speed is stated (*13*, 5/2/50) to have increased 1 km between 1948 and 1949.

1949	"Commercial" speed in 1949 is stated (*13*, 12/11/49) to be 1.9 kms below the previous level.
1950-56	*70*, 52.
1957-58	*45*, 554 f.
1959	*90*, 1960, No. 3.
1960	*46a*, 539.

The section, or "commercial," speed of freight trains includes stops at way stations.

C-19 *Average "technical" speed*

1913	*12*, 10.
1922/23-33	*14*, 56.
1934-40	*25*, 294.
1945, 1950-56	*70*, 54.
1947	"Technical" speed in 1947 is stated (*76*, 108) to be 135% of 1935.
1957-58	*45*, 554 f.
1959-60	*46a*, 539.

The "technical" speed of freight trains excludes stops at way stations.

C-20 *Average gross train weight*

1913	*23*, 132.
1924/25-33	*14*, 56.
1934-40	*25*, 294. For 1940, *70*, 61, gives 1,301 tons.
1941	*69*, 1947, No. 12, 5. For first half of year.
1945, 1950-56	*70*, 61.
1946	Gross train weight is stated (*90*, 1947, No. 10, 23) to have decreased by 28 tons between 1945 and 1946.
1947	Gross train weight in 1947 is stated (*90*, 1948, No. 8, 2) to be 4.6% less than in 1940.
1948	Gross train weight in 1948 is stated (*73*, 5/1/49) to be 42 tons above prewar norm.
1949	It is stated (*13*, 5/14/50) that in the summer of 1950 gross train weight was to increase 27 tons over 1949 and 119 tons over 1940.
1957-58	*45*, 557.
1959	*46*, 498.
1960	*46a*, 540.

C-21 *Average net train weight*

1913A, 1921/22-33	*14*, 56. For 1913, *59*, 203, gives 297 tons and *38*, vol. 53, 10, gives 320.6 tons. For 1922/23-24/25, *38*, vol. 53, 10, gives 291, 331, and 388 tons.

1913	Assumed to be the same as for 1913A.
1914-15, 1919-21	*59,* 203.
1934-37	*16,* 305. For 1937, *70,* 59, gives 682 tons.
1938, 1946-49	Gross train weight (series C-20) times ratio of net to gross train weight interpolated between neighboring years.
1939	*23,* 132.
1940	*69,* 1946, No. 8-9, 5.
1945, 1950-56	*70,* 59.
1957-58	*45,* 557.
1959-60	*46a,* 540.

C-22 *Total train kilometers*

1913A, 1913, 1921/22	*38,* vol. 104, 7; vol. 53, 7.
1922/23-33	*14,* 48.
1934-35	*65,* 430.
1936-40, 1945-60	Operating ton-kms (series C-6) divided by avg. net train weight (series C-21).

IV. Locomotives

C-23 *Locomotives in inventory fleet*

1913A, 1921/22-26/27	*38,* vol. 36, 6; vol. 104, 34. For 1913A and 1921/22-22/23, annual averages.
1913, 1932, 1937	*84,* 469.
1928, 1938-40, 1950	Total tractive effort of locomotives in inventory fleet (series C-24) divided by avg. tractive effort per locomotive derived as 11.3 tons for 1928 (*12,* 10), 14.6 tons for 1938 (read from a graph, *69,* 1947, No. 11, 12), 14.9 tons for 1939 and 1940 (*23,* 140; *12,* 10), and 16.9 tons for 1950 (interpolated on the basis of rate of increase).
1929-31, 1933-34	Based on locomotives under railroad jurisdiction (*14,* 44) and percentage that they were of inventory fleet (interpolated between percentages for 1928, 1932, and 1935, which were derived from locomotives under railroad jurisdiction in *14,* 44, and locomotives in inventory fleet for these years).
1935-36	*47,* 121.
1942-43	Locomotives in inventory fleet at beginning of 1943 (taken as end of 1942) are stated (*86,* 104) to be 85% of 1941 (taken as end of 1940) and to have increased by 2,000 by end of 1943.

	1944-45	Based on locomotives in 1943 and assumed minimum annual increases of 600 per year.
	1953	*132*, 168.
	1954	Locomotives in inventory fleet in 1953 plus 1,036 locomotives produced in 1954 (*44*, 56).
	1955	Locomotives in inventory fleet in 1954 plus 982 locomotives produced in 1955 (*44*, 56).
C-24	*Total tractive effort of locomotives in inventory fleet*	
	1913A, 1929-31, 1933-34, 1945, 1953, 1955	Locomotives in inventory fleet (series C-23) times avg. tractive effort per locomotive, derived as 10.2 tons for 1913A (assumed to be same as for 1913, *12*, 10), 11.6, 12.0, 12.4, 13.0, and 13.3 tons for 1929-31 and 1933-34 (read from a graph, *69*, 1947, No. 11, 12), 15.9 and 17.5 tons for 1945 and 1953 (interpolated on the basis of rate of increase), and 17.9 tons for 1955 (20.1% increase in postwar period, *85*, 1956, No. 10, 40).
	1913	Total tractive effort in 1937 is stated (*43*, 182) to be 194% of effort in 1913.
	1928	Total tractive effort in 1928 is stated (*43*, 182) to be 106.9% of effort in 1913.
	1932	Total tractive effort in 1932 is stated (*43*, 182) to be 141.7% of effort in 1913.
	1935-36	*47*, 121.
	1937	*84*, 469.
	1938	Interpolated.
	1939	Total tractive effort in 1939 is stated (*43*, 182) to be 214.5% of effort in 1913.
	1940	Avg. tractive effort of a steam locomotive in 1941 (taken as end of 1940) is stated to be 225% of effort in 1928. However, since this contradicts absolute figures for avg. tractive effort (*12*, 10), it must apply to *total* tractive effort.
	1950	Total tractive effort per 100 kms is stated (*85*, 1952, No. 4, 33) to have increased 16% during the postwar five year plan.
C-25	*Average daily kilometers per locomotive-day*	
Col. 1	1913A, 1917-21/22	*38*, vol. 53, 10; vol. 2, 39; vol. 7, 108. For 1913A, covers all types of traffic.
	1913, 1940	*44*, 177. For 1940, also *85*, 1952, No. 4, 36.
	1922/23-33	*14*, 56.

	1934-36	*84*, 409.
	1937	*69*, 1947, No. 12, 5.
	1938	Avg. daily kms per locomotive-day in 1938 are stated (*13*, 3/18/39) to be 87.3 kms more than in 1933.
	1939	*23*, 132.
	1945, 1950-55	*70*, 57.
	1948-49	Based on announced annual relative for 1949 (108.4%, *13*, 5/24/50) and statement (*13*, 4/23/50) that avg. daily kms per locomotive-day in 1949 were 18 kms more than in 1948.
	1956-58	*45*, 555.
	1959-60	*46a*, 539.
Cols. 2, 3, and 4		
	1945, 1950-55	*70*, 57.
	1956-58	*45*, 555.
	1959-60	*46a*, 539.

V. Freight Cars

C-26 *Active fleet, revenue trains*

Col. 1	1913A, 1913, 1917-20	*38*, vol. 104, 6; vol. 2, 16 ff.
	1921-60	ADC (series C-4) times turnaround time of freight cars (series C-29). *38*, vol. 19, 42 f, and vol. 36, 63, gives 228.5, 214.3, 190.6, and 209.4 for 1921-23/24.

C-27 *Fleet under railroad jurisdiction*

	1913A, 1913, 1921/22-22/23	*38*, vol. 6; vol. 53, 6.
	1920-21	Based on inventory fleet and ratio of fleet under RR jurisdiction to inventory fleet per verst of line operated (derived from *38*, vol. 7, 106 f).
	1923/24-33	*14*, 44.
	1934-35	*65*, 430.
	1936-37, 1939-40, 1944-45, 1950, 1955	Based on active fleet (series C-26) and percentage that active fleet was of fleet under RR jurisdiction (86.7% and 86.2% for 1937 and 1940, *29*, 98; interpolated for other years).
	1938	Fleet under RR jurisdiction in 1938 is stated (*13*, 3/9/39) to be 134% of 1934 fleet.
	1942-43	Fleet under RR jurisdiction at beginning of 1943 is stated (*86*, 104) to be 80% smaller than in 1941 (taken as end of 1940) and to have increased by 56,000 by end of 1943.

C-28 *Percentage of four-axle units in total inventory fleet*

1928, 1932-35	*65,* XLI.
1929, 1931	Interpolated.
1930	*62,* 22.
1936-40	*49a,* 24.
1945, 1955	Extrapolated.
1946, 1954	*13,* 4/20/55.
1950	Based on statement (*13,* 6/6/51) that 76% of all freight cars are equipped with automatic brakes and statement (*39,* 153) that 97% of 4-axle and 64% of 2-axle freight cars are equipped with automatic brakes.
1958	*90,* 1960, No. 3, 30.

C-29 *Turnaround time, active fleet*

Col. 1	1913, 1940	*44,* 177. For 1913, also *48,* 1939, No. 8, 165. For 1940, also *88,* 384.
	1920/21-21/22	*38,* vol. 53, 19.
	1922/23-33	*18,* 55.
	1934-35	*65,* 432.
	1936-37	*84,* 409.
	1938	*48,* 1939, No. 8, 165.
	1939	*23,* 132.
	1941	*75,* vol. 57, 394.
	1942-43	*86,* 104.
	1944	Interpolated.
	1945, 1950-56	*70,* 48.
	1946	Turnaround time is stated (*88,* 21) to have been speeded up by 0.85 days between 1945 and 1946.
	1947	*79,* 18.
	1948	Turnaround time is stated (*13,* 11/30/49) to have been reduced 0.92 days between 1947 and 1948.
	1949	Based on unrevised turnaround time in 1950 (derived as 7.57 days from statement, *13,* 11/11/51, that turnaround time decreased 58 hours between 1946 and 1950) and announced annual relative (92.4%, *13,* 12/31/51).
	1957-58	*45,* 555.
	1959	*46,* 497.
	1960	*46a,* 539.
Col. 2	1913, 1920/21-31, 1939, 1941-44, 1946-49, 1959-60	Converted from days in col. 1.
	1932	*90,* 1945, No. 1, 11.
	1933-35	*65,* 433.

1936-38	*63,* 1939, No. 6, 25.
1940, 1945, 1950-56	*70,* 49.
1957-58	*45,* 556.

C-30 Average daily kilometers per active car-day

1913A, 1922/23-33	*14,* 55. For 1913A, covers revenue freight trains only. For 1913A, *38,* vol. 104, 8, gives 72 kms for all freight trains.
1913	Assumed to be same as for 1913A. *10,* 282, gives 72 kms.
1917-21/22	*38,* vol. 2, 39; vol. 53, 10 and 19.
1934-38	*63,* 1939, No. 6, 25.
1939	*23,* 132.
1940	*25,* 304.
1941-44, 1946-49	Total turnaround trip (series C-31) divided by turnaround time (series C-29).
1945, 1950-56	*70,* 48.
1957-58	*45,* 555.
1959	*46,* 497.
1960	*46a,* 539.

C-31 Average total turnaround trip

1913A, 1913, 1920/21-26/27, 1936-39, 1945, 1950-57, 1960	Turnaround time (series C-29) times avg. daily kms per car-day (series C-30).
1928-33	*14,* 55.
1934-35	*65,* 432.
1940	*88,* 384.
1941-44	Total turnaround trips in 1941, 1942, 1943, and 1944 are stated (*90,* 1945, No. 5-6, 43) to be 106.6%, 126.5%, 132.1%, and 123.5%, respectively, of 1940.
1946-49	Loaded turnaround trip (series C-32) divided by percentage that loaded was of total trip (100 minus col. 2 of series C-33).
1958-59	*90,* 1960, No. 3, 35.

C-32 Average loaded turnaround trip

1913A, 1913	Based on total turnaround trip (series C-31) and percentage that loaded is of total (71.4% for 1913A, *38,* vol. 53, 10; assumed same for 1913).
1920/21-21/22	*38,* vol. 53, 19.
1922/23-33	*14,* 55.
1934-35	*65,* 432.

	1936-38	Based on ALH (series C-3) and percentage that loaded turnaround trip is of ALH (103.3%, 105.1%, and 106.3% for 1936-38, *68,* vol. XI, 427).
	1939	*25,* 308.
	1940, 1944-45, 1950-57	Total turnaround trip (series C-31) minus empty turnaround trip (series C-33).
	1941-43	Loaded turnaround trips in 1941, 1942, and 1943 are stated (*90,* 1945, No. 5-6, 43) to be 110.1%, 125.7%, and 126.2%, respectively, of 1940.
	1946, 1949	Interpolated.
	1947-48	Based on statement (*13,* 7/1/51) that average loaded turnaround trip in 1947 and 1948 was 7.4% and 8.9% longer than average length of haul (series C-3).
	1958-60	*90,* 1960, No. 3, 35; 1961, No. 3, 31.
C-33	*Average empty turnaround trip*	
Col. 1	1913A, 1913, 1921-39, 1941, 1960	Total turnaround trip (series C-31) minus loaded turnaround trip (series C-32).
	1940	*88,* 384.
	1942-44	*90,* 1946, No. 7, 30.
	1945-59	Based on total turnaround trip (series C-31) and percentage that empty is of total (col. 2).
Col. 2	1913, 1929-33	*14,* 55.
	1920/21-28, 1940-44, 1960	Empty turnaround trip (col. 1) divided by total turnaround trip (series C-31).
	1934-35	*65,* 432.
	1936-37	*84,* 409.
	1938-39, 1946-53	*24a,* 300.
	1945, 1954-56	*70,* 48.
	1957	Interpolated.
	1958-59	*90,* 1960, No. 3, 35.

VI. Railroad Network and Traffic Density

C-34	*Total road operated, annual averages*	
	1913A, 1913-16, 1921	*38,* vol. 104, 2; vol. 3, 14 ff; vol. 7, 107. Converted from versts at 1 verst = 1.067 kms.
	1917-20, 1921/22-33	*14,* 6 f.
	1934-35	*65,* 440.
	1936	*16,* 293.

1937	Tariff ton-kms (series C-1) divided by freight traffic density (series C-36). *16,* 293, gives 85.3 thous. kms.
1938-39, 1943-60	Unweighted annual averages derived from two successive end-of-year figures (series C-35). For 1953, also *19,* 8, where road operated in 1955 is stated to be 155% of road operated in 1928. For 1939, *11,* 30, gives 88.4 thous. kms.
1940	*49,* 5.

The figures for 1913-37 and 1940 are weighted annual averages obtained by weighting the length of lines in permanent operation by the number of days operated by the railroads under the Ministry of Transportation. The figures for 1938-39 and 1943-60 are unweighted annual averages.

C-35 *Total road operated, end of year*

1913A, 1913, 1917, 1920-40, 1945-56	*70,* 28.
1914-16, 1918-19	Estimated from total road built at end of year plus undated spurs minus railroads ceded to other countries multiplied by a factor to convert road built into road operated (*38,* vol. 42, 52 ff). This factor was derived from the known road built and the road operated at end of 1917. Road operated is distance between centers of passenger stations. Road built represents total length of main tracks between connecting and ending points (*31,* 143).
1942-43	Railroad network is stated (*43,* 193) to have increased 18,746 kms, or 29.8%, between 1942 and 1943.
1944	Railroad network is stated (*43,* 200) to have increased 29,000 kms between 1943 and 1944.
1957-58	*45,* 544.
1959-60	*46a,* 535.

C-36 *Freight traffic density*

1913A, 1913	*38,* vol. 104, 3. For wide-gauge and revenue trains only. For 1913, also *14,* 8.
1917-20, 1921/22	*64,* 248 f.
1921, 1936, 1938-40, 1943-60	Tariff ton-kms (series C-1) divided by avg. road operated (series C-34). For 1953, *48,* 1954, No. 6, 56, gives 7,100 thous. kms. For 1954, *13,* 10/22/55, gives 7,600 thous. kms. For 1954, *90,* 1956, No. 4, 40, gives 8,600 thous. kms.

	1922/23-33	*14*, 8.
	1934-35	*65*, 417.
	1937	*84*, 181.
C-37	*Passenger traffic density*	
	1913A, 1913	*38*, vol. 104, 4. For 1913, also *14*, 8.
	1921-21/22, 1936, 1938-40, 1945-60	Passenger-kms (series C-9) divided by avg. road operated (series C-34).
	1922/23-33	*14*, 8.
	1934-35	*65*, 417.
	1937	*43*, 181.

VII. Railroad Labor Force and Productivity

C-38	*Composite passenger-ton-kilometers*	
Col. 1	1913A, 1913, 1921-26/27, 1930-40, 1945-60	Passenger-kms (series C-9) plus tariff ton-kms (series C-1).
	1928-29	*74*, 278.
Col. 2	1913, 1928-40, 1945-60	Passenger-kms (series C-9) plus operating ton-kms (series C-6).
C-39	*Labor productivity*	
Col. 1	1913A, 1913	*38*, vol. 104, 10. For 1913, also *29*, 169.
	1925/26-26/27	*14*, 60.
	1928-30	*74*, 278.
	1931-40, 1950-60	Composite passenger-ton-kms (series C-38) divided by operating labor force (series C-40). For 1950, also *44*, 34, where productivity in 1950 is stated to be 295% of 1928 and 110% of 1940. For 1951-55, also *44*, 34, where productivity in 1951-55 is stated to be 109%, 113%, 120%, 124%, and 139%, respectively, of 1950. For 1952, also *43*, 279, where productivity in 1952 is stated to be 112.8% of 1950. For 1953, also *13*, 5/5/54, and *85*, 1955, No. 4, 66, where productivity in 1953 is stated to be 119.6% of 1950 and 131.1% of 1940. For 1954, also *13*, 2/22/55, where productivity in 1954 is stated to be 124.1% of 1950.
	1945-49	Based on productivity in 1950 and announced annual relatives for 1946-50 (109.6%, 102.9%, 116.0%, 111.5%, and 110.4%, *85*, 1955, No. 4, 66).
Col. 2	1913, 1928-40, 1945-60	Composite passenger-ton-kms (series C-38, col. 2) divided by operating labor force (series C-40).

For data derived from slightly different coverages, see *74,* 278; *78,* 16; and *14,* 61.

C-40 Operating labor force

1913A, 1913	*38,* vol. 104, 10. Includes 132.6 and 116.3 thous. temporary workers in 1913A and 1913, respectively. For 1913, also *14,* 58, and *84,* 121, which covers workers and employees on operating appropriations payroll. This coverage is about 15% broader than 1932 coverage.
1925/26-26/27	*14,* 58. Covers workers and employees on operating appropriations payroll.
1928-31	*74,* 278. Also, *14,* 159. For 1928, also *44,* 180.
1932, 1934-37	*84,* 557 and 553. Covers workers and employees in railroad operations. For 1932 and 1934-35, *74,* 278, gives 1,016, 1,111, and 1,209 thous. workers, coverage being more restricted.
1933, 1939	Composite passenger-ton-kms in all trains (derived as 254.6 and 501.8 bill. from series C-38, col. 2, plus operating ton-kms in nonrevenue trains, *14,* 21, for 1933, and interpolated from data in *28,* 239, for 1939) divided by labor productivity for all trains (249.3 and 384.0 thous. composite passenger-ton-kms per operating worker, *29,* 169). For 1933, *74,* 278, gives 992 thous. workers, restricted coverage.
1938	*63,* 1939, No. 8, 7.
1940, 1950-56	*70,* 64.
1945, 1947-49	Composite passenger-ton-kms (series C-38) divided by labor productivity (series C-39).
1946	*60,* 52.
1957-58	*45,* 558.
1959-60	*46a,* 541.

For variant coverages, see *84,* 548; *60,* 52; *38,* vol. 104, 10; and *14,* 59. For 1940, variants relating to inclusion of railroad operations in acquired territory appear *12a,* 532.

VIII. Powered Freight Traffic on Inland Waterways

C-41. Ton-kilometers

Col. 1	1913	*32*, 32. Excludes rafting.
	1924-27	*38*, vol. 83, 2; vol. 118.
	1928	*83*, 11.
	1929-35	*56*, 6. For 1929-33, also *83*, 11. For 1933-35, also *65*, 443.
	1936-38	*82*, 1940, No. 9, 3.
	1939	*51*, 2/11/41.
	1940, 1950, 1954-55	*44*, 181.
	1945-47	Tons originated (series C-42) times ALH (series C-43).
	1948	Based on 1947 traffic and annual relative (computed as 126.7% from statement, *57*, 20, that shipments in 1947 and 1948 were 135% and 171% of shipments in 1945).
	1949	Based on 1948 traffic and announced annual relative (120.4%, *55*, 1950, No. 3, 1).
	1951	Based on 1950 traffic and annual relative (computed as 112.5% from annual relative for 1952 and statement, *55*, 1953, No. 2, 3, that traffic increased 26% during first 2 years of current five year plan).
	1952	Based on 1951 traffic and announced annual relative (112%, *51*, 1/23/53).
	1953	Traffic in 1953 is stated (*82*, 3/11/54) to be 163% of traffic in 1940.
Col. 2	1913	*84*, 194.
	1923-29	*38*, vol. 83, 2; vol. 118, 2.
	1940	*44*, 181.
	1945-55	*70*, 116.
	1956-59	*67*, 168.
	1960	*46a*, 545.

C-42. Tons originated

Col. 1	1913	Ton-kms (series C-41) divided by ALH (series C-43).
	1924-28	*38*, vol. 83, 2; vol. 118, 2. For 1928, also *83*, 11.
	1929-35	*56*, 6. For 1934, excludes double origination of oil by the Moscow-Oka and the Northwestern Steamship Agencies, which was not considered double

		origination in previous years and was included in total tons originated (53,293,743). For 1933-34, also *83*, 11, which excludes baggage.
	1936	*48*, 1937, No. 8, 197.
	1937-38	*82*, 1940, No. 9, 3.
	1939	*21*, 300.
	1940, 1950, 1954-55	*44*, 181.
	1945	*73*, 3/6/46.
	1946	Shipments in 1946 are stated (*58*, 138) to be 2,760,000 tons more than in 1945.
	1947-49	Based on 1946 shipments and announced annual relatives for 1947-49 (118.7%, 130%, and 121.2%, *55*, 1948, No. 2, 1; 1949, No. 5, 1; 1950, No. 3, 1).
	1951-52	Based on 1950 shipments and annual relatives (announced as 113% for 1951, *13*, 1/29/52; computed as 107.6% for 1952 from statement, *54*, 1952, No. 1, 1, that shipments were to increase 12.3% in 1952 and statement, *41*, 1953, No. 1, 1, that 95.8% of 1952 plan was fulfilled).
	1953	Based on 1954 shipments and announced annual relative (111%, *51*, 1/21/55).
Col. 2	1913	*82*, 1940, No. 9, 3.
	1923-29	*58*, vol. 83, 2; vol. 118, 2.
	1930	*84*, 197.
	1940	*44*, 181.
	1945-55	*70*, 116.
	1956-59	*67*, 169.
	1960	*46a*, 545.

In *41*, 1953, No. 1, 1, Shashkov stated that shipments (*perevozki*) increased 26% during the first two years of the current five year plan. Despite his use of the word shipments (*perevozki*), Shashkov must have been referring to ton-kilometers since otherwise his statement does not agree with the annual relative for 1952 nor with a statement by Vakhturov in *55*, 1953, No. 2, 3, that traffic (*gruzooborot*) increased 26% during the first two years of the current five year plan.

C-43 Average length of haul

Col. 1	1913, 1936-39	*48*, 1941, No. 1, 45.
	1924-29, 1931, 1940, 1948-49, 1951-54	Ton-kms (series C-41) divided by tons originated (series C-42).
	1930, 1932-35	*56*, 6. For 1932-35, also *48*, 1941, No. 1, 45.
	1945-47	*30*, 24 and 26.
	1950, 1955	*85*, 1956, No. 7, 21. Also, *13*, 7/31/56.

Col. 2	1913, 1923-29, 1945-60	Ton-kms under ministry and other organizations (series C-41, col. 2) divided by corresponding tons originated (series C-42, col. 2).
	1940	*89,* 42.

IX. Maritime Freight Traffic Carried in Soviet Bottoms

C-44	*Total ton-kilometers*	
Col. 1	1913A, 1913, 1939	Sum of domestic ton-kms (series C-47) and foreign ton-kms (derived as 7.8, 7.1, and 6.8 bill. from foreign tons originated and foreign ALH, which were derived from total and domestic tons originated and interpolations). For 1913, also *44,* 181.
	1928	Ton-kms for terminated trips (col. 2) converted into ton-kms for originated trips by factor 0.9. For further details, see Appendix B.
	1929-38	*82,* 1940, No. 9, 3. For 1929, also *44,* 181.
	1940	*12,* 6.
	1945-55	*70,* 95. Converted from nautical ton-miles.
	1956-58	*67,* 168.
	1959-60	*46a,* 531.
Col. 2	1928	*66,* 40.
	1929-35	*42,* 8.
C-45	*Total tons originated*	
Col. 1	1913A	*82,* 1932, No. 10, 40. Assumed to refer to Empire territory.
	1913	Sum of domestic tons originated (series C-48) and foreign tons originated (derived as 2.03 mill. from foreign tons originated carried in bottoms of all flags, *42,* 6, and statement, *40,* 1947, No. 11, 8, that 9.6% of export and import traffic was carried in Soviet bottoms). A later source (*44,* 181) gives 15.1 mill. tons.
	1920-27	*38,* vol. 8, 219; vol. 84, 2 f; vol. 107, 3 f. For 1920-21, petty cabotage only; for 1922-27, sum of petty and grand cabotage.
	1928	Tons originated for terminated trips (col. 3) converted into tons originated for originated trips by factor 1.05. For further details, see Appendix B.

	1929-38	*82,* 1940, No. 9, 3.
	1939	Interpolated by ratio of domestic tons originated (series C-48) to total between 1937 and 1940.
	1940	*12,* 6.
	1945-55	*70,* 95.
	1956-59	*67,* 169.
	1960	*46a,* 543.
Col. 2	1929-35	*42,* 6.
Col. 3	1928, 1936	*48,* 1937, No. 8, 197.
	1929-35	*42,* 8.

C-46 Average length of total haul

1913A, 1913, 1928-39, 1945-60	Total ton-kms (series C-44) divided by total tons originated (series C-45).
1940	*12,* 6. Also, *30,* 24.

C-47 Domestic ton-kilometers

1913A, 1913, 1946-54	Domestic tons originated (series C-48) times ALH (series C-49).
1928-34	Estimated from ton-kms for terminated trips. For details, see Appendix B. For 1932, also *28,* 20.
1935	*42,* 6.
1936	*82,* 1937, No. 3, 9. Preliminary.
1937, 1940	*28,* 20.
1938	Petty cabotage freight traffic in 1940 is stated (*36,* 5) to be 115.1% of 1938. Applied to domestic ton-kms since petty cabotage formed by for the greatest part of domestic ton-kms.
1939	*21,* 300.
1945	Domestic maritime ton-kms are stated (*29,* 13) to be 3% of ton-kms carried by all types of transportation, and railroad ton-kms (series C-1) are stated (*ibid.*) to be 91.7% of total ton-kms. The former percentage has been adjusted downward by 0.05% in order to fit in with data or railroad as well as river transportation.

C-48 Domestic tons originated

Col. 1	1913A	*38,* vol. 84, 2. Covers traffic carried in bottoms of all flags.
	1913, 1933-35	*42,* 6. For 1913, covers traffic carried in bottoms of all flags.

	1928-32	Sum of col. 2 and estimated local freight traffic (taken as series in *82*, 1940, No. 9, 3, minus Appendix Table B-4).
	1936	*82*, 1937, No. 3, 9. Preliminary.
	1937, 1940	*28*, 20.
	1938	Interpolated by ratio of domestic to total tons originated (series C-45) between 1937 and 1940.
	1939	*21*, 300.
	1945	Domestic ton-kms (series C-47) divided by ALH (series C-49).
	1946-54	Based on total tons originated (series C-45) and ratio $\frac{1\text{ f—1t}}{1\text{ f—1d}}$. See Appendix B.
Col. 2	1924-28	*38*, vol. 107, 3 f. Sum of petty and grand cabotage freight traffic carried by Soviet foreign trade fleet and domestic freight traffic of the Caspian Sea maritime fleet.
	1929-35	*42*, 6. Sum of petty and grand cabotage.
C-49	*Average length of domestic haul*	
	1913A, 1913, 1928-31, 1933-34	Estimated and adjusted for rounding of ton-kms. See Appendix B.
	1932, 1937, 1940, 1945	*29*, 13.
	1935-36, 1938-39	Domestic ton-kms (series C-47) divided by domestic tons originated (series C-48).
	1946	Assumed at level of preceding year and adjusted for rounding of ton-kms.
	1947-53	Interpolated and adjusted for rounding of ton-kms. See Appendix B.
	1954	1928-30 weighted avg. obtained from ton-kms (series C-47) for 1928-40 divided by tons originated for those years (series C-48).

X. Oil Pipeline Traffic

C-50	*Ton-kilometers*	
	1913, 1920/21-34	*65*, 126. Tons originated for each pipeline times corresponding length of pipeline.
	1935-36, 1938-39	Interpolated.
	1937, 1940, 1945, 1950-56	*70*, 210.
	1946	Pipeline traffic is stated (*50*, 42) to be 0.9% and railroad traffic (taken as series C-1) 84.9% of aggregate volume of freight traffic.
	1957-58	*45*, 572.
	1959-60	*46a*, 552.

C-51	*Tons originated*	
	1913, 1920/21-34	*65*, 126.
	1935-36	*48*, 1938, No. 1, 53.
	1937, 1940, 1945, 1950-58	*45*, 572.
	1959-60	*46a*, 552.
C-52	*Average length of haul*	
	1913, 1920/21-34, 1937, 1940, 1945, 1950-60	Ton-kms (series C-50) divided by tons originated (series C-51).
	1935-36	*95*, 175.

XI. Motor Freight Traffic

C-53	*Ton-kilometers*	
	1913, 1917, 1920, 1923/24-40, 1945-56	*70*, 155.
	1957-58	*45*, 573.
	1959	*67*, 168.
	1960	*46a*, 553.
C-54	*Tons originated*	
	1913, 1917, 1920, 1923/24-40, 1945-56	*70*, 155.
	1957-58	*45*, 573.
	1959-60	*46a*, 553.
C-55	*Average length of haul*	
	1913, 1917, 1920, 1923/24-40, 1945-60	Ton-kms (series C-53 divided by tons originated (series C-54).

Bibliography

Soviet Works

1. Balzak, S. S.; Vasyutin, V. F.; and Feigin, Ya. G. (eds.). *Economic Geography of the USSR* (translated from the Russian). New York, 1949.
2. Beliunov, S. A., *et al. Planirovanie na zheleznodorozhom transporte* [Planning in Railroad Transportation]. Moscow, 1948.
3. *Bol'shaia sovetskaia entsiklopediia* [The Great Soviet Encyclopedia]. 1st ed. Moscow, 1926-47.
4. Chudov, A. S. *Sebestoimost' zheleznodorozhnykh perevozok i puti ee snizheniia* [Cost of Railroad Shipping and Ways of Reducing It]. Moscow, 1956.
5. Danilov, S. K. (ed.). *Ekonomika transporta* [Economics of Transportation]. Moscow, 1956.
6. *Eksploatatsiia zheleznykh dorog* [Operation of the Railroads]. Monthly journal.
7. *Ezhemesiachnyi biulleten' transportnoi statistiki* [Monthly Bulletin of Transportation Statistics].
8. *Five Year Plan for the Rehabilitation and Development of the National Economy of the USSR, 1946-1950* (translated from the Russian). London, 1946.
9. Galitskii, A. E. *Planirovanie perevozok* [Planning of Shipments]. Moscow, 1939.
10. Gibshman, A. E., *et al. Ekonomika transporta* [Economics of Transportation]. Moscow, 1956.
11. Gorinov, A. V. *Proektirovanie zheleznykh dorog* [Railroad Planning]. Moscow, 1948.
12. —— and Divnogorskii, N. P. *Razvitie tekhniki zheleznodorozhnogo transporta* [Development of Railroad Transportation Technology]. Moscow, 1948.

12a. *Gosudarstvennyi plan razvitiia narodnogo khoziaistva SSSR na 1941 god* [The State Plan for the Development of the USSR National Economy for 1941]. Moscow, 1941 (reprinted by the American Council of Learned Societies, 1948).

13. *Gudok* [Whistle]. Daily newspaper. USSR Ministry of Communications.
14. Iakobi, A. (ed.). *Zheleznye dorogi SSSR v tsifrakh* [USSR Railroads in Figures]. Moscow, 1935.
15. Iakubov, L. S. *Osnovy zheleznodorozhnoi statistiki* [Principles of Railroad Statistics]. 2nd ed. Moscow, 1959.
16. Ioffe, Ia. A. *SSSR i kapitalisticheskie strany, 1913-1937* [The USSR and the Capitalist Countries, 1913-1937]. Moscow and Leningrad, 1939.
17. *Itogi vypolneniia vtorogo piatiletnego plana razvitiia narodnogo khoziaistva SSSR* [The Fulfillment of the Second Five Year Plan for the Development of the USSR National Economy]. Moscow, 1939.

18. *Izvestia* [News]. Daily newspaper. USSR Council of Deputies.
19. Kaganovich, L. M. *Uluchshit' rabotu i organizovat' novyi pod'em zheleznodorozhnogo transporta* [Improve Railroad Transportation]. Moscow, 1954.
20. Khachaturov, T. S. *Ekonomika transporta* [The Economics of Transportation]. Moscow, 1959.
21. ——. *Osnovy ekonomiki zheleznodorozhnogo transporta* [The Economic Principles of Railroad Transportation]. Moscow, 1946.
22. ——, *et al. Razvitie transporta i sviazi v SSSR* [Development of Transportation and Communications in the USSR]. Moscow, 1948.
23. ——. *Zheleznodorozhnyi transport SSSR* [Railroad Transportation in the USSR]. Moscow, 1952.
24. ——. *Zheleznodorozhnyi transport v velikoi otechestvennoi voine* [Railroad Transportation During World War II]. Moscow, 1943.
24a. Khanukov, E. D. *Transport i razmeshchenie proizvodstva* [Transportation and Distribution of Production]. Moscow, 1955.
25. ——, and Chernyshev, V. I. (eds.). *Voprosy ekonomiki zheleznodorozhnogo transporta* [Economic Location Problems of Railroad Transportation]. Moscow, 1948.
26. Kochetov, I. V. *Statistika zheleznodorozhnoi transporta* [Statistics of Railroad Transportation]. Moscow, 1941.
27. ——. *Zheleznodorozhnaia statistika* [Railroad Statistics]. Moscow, 1939.
28. ——. ——. 1st ed. Moscow, 1948.
29. ——. ——. 2nd ed. Moscow, 1953.
30. Koldomasov, Iu. I. *Osnovy planirovaniia perevozok na zheleznodorozhnom transporte* [The Principles of Planning Shipments in Railroad Transportation]. Moscow, 1949.
31. *Kratkii tekhnicheskii zheleznodorozhnyi slovar'* [Brief Technical Railroad Dictionary]. Moscow, 1946.
32. Lebedev, E. P. *Transportnaia statistika* [Transportation Statistics]. Moscow, 1953.
33. Liashchenko, P. I. *Istoriia narodnogo khoziaistva SSSR* [History of the USSR National Economy]. Volume II. Moscow, 1952.
34. *Lokomotivy i vagony v promyshlennosti* [Locomotives and Railroad Cars in Industry]. Moscow, 1936.
35. Lokshin, E. *Promyshlennost' SSSR v novoi stalinskoi piatiletke* [USSR Industry in the New Stalin Five Year Plan]. Moscow, 1946.
36. Malenkov, G. M. *O zadachakh partiinykh organizatsii v oblasti promyshlennosti i transporta* [On the Tasks of Party Organizations in Industry and Transportation]. Moscow, 1941.
37. *Mashinostroenie* [Machine Building]. Monthly journal. Ministry of Machine Building and Ministry of Defense.
38. *Materialy po statistike zheleznodorozhnogo transporta* [Materials on the Statistics of Railroad Transportation]. Issues 2-118. Moscow, 1921-31.
39. Modzolevskii, I. V., *et al. Obshchii kurs zheleznykh dorog* [General Course on Railroads]. Moscow, 1951.
40. *Morskoi flot* [Maritime Fleet]. Monthly journal.

41. *Morskoi i rechnoi flot* [Maritime and River Fleet]. Monthly journal.
42. *Morskoi transport v 1935 godu* [Maritime Transportation in 1935]. Moscow, 1936.
43. Naporko, A. G. *Ocherki razvitiia zheleznodorozhnogo transporta SSSR* [Outline of the Development of Railroad Transportation in the USSR]. Moscow, 1954.
44. *Narodnoe khoziaistvo SSSR* [The USSR National Economy]. Moscow, 1956.
45. *Narodnoe khoziaistvo SSSR v 1958* [The USSR National Economy in 1958]. Moscow, 1959.
46. *Narodnoe khoziaistvo SSSR v 1959* [The USSR National Economy in 1959]. Moscow, 1960.
46a. *Narodnoe khoziaistvo v 1960* [The USSR National Economy in 1960]. Moscow, 1961.
47. *Narodno-khoziaistvennyi plan na 1937 god* [The National Economic Plan for 1937]. Moscow, 1937.
48. *Planovoe khoziaistvo* [Planned Economy]. Monthly journal. USSR State Planning Office.
49. Potapov, V. E., and Deribas, A. T. *Kommercheskaia eksploatatsiia zheleznykh dorog SSSR* [Commercial Operation of USSR Railroads]. Moscow, 1950.
49a. Povorozhenko, V. V. *Organizatsiia gruzovoi raboty na zheleznodorozhnom transporte* [Organization of Shipping by Railroad]. Moscow, 1947.
50. ———. *Organizatsiia gruzovykh perevozok i kommercheskoi raboty na zheleznodorozhnom transporte SSSR* [Organization of Shipping and Commercial Transportation of USSR Railroads]. Moscow, 1951.
51. *Pravda* [Truth]. Daily newspaper. Central Committee of the Communist Party.
52. *Problemy ekonomiki* [Problems of Economics]. Monthly journal. Communist Academy. Economics Institute.
53. *Promyshlennost' SSSR* [Industry of the USSR]. Moscow, 1957.
54. *Rechnoi flot* [The River Fleet]. Monthly journal.
55. *Rechnoi transport* [River Transportation]. Monthly journal.
56. *Rechnoi transport* v *1935 godu* [River Transportation in 1935]. Moscow, 1936.
57. Shashkov, Z. A. *Rechnoi transport SSSR i ego rol' v gruzooborote strany* [River Transportation and Its Role in the Country's Freight Traffic]. Moscow, 1949.
58. ———. *Rechnoi transport v novoi stalinskoi piatiletke* [River Transportation in the New Stalin Five Year Plan]. Moscow, 1947.
59. Shmukker, M. M. *Ocherki finansov i ekonomiki zheleznodorozhnogo transporta Rossii za 1913-1922 gody* [Outline of the Finances and Economics of Railroad Transportation in Russia from 1913 to 1922]. Moscow, 1923.
60. Shvetsov, V. N. *Statistika truda na zheleznodorozhnom transporte* [Labor Statistics for Railroad Transportation]. Moscow, 1956.

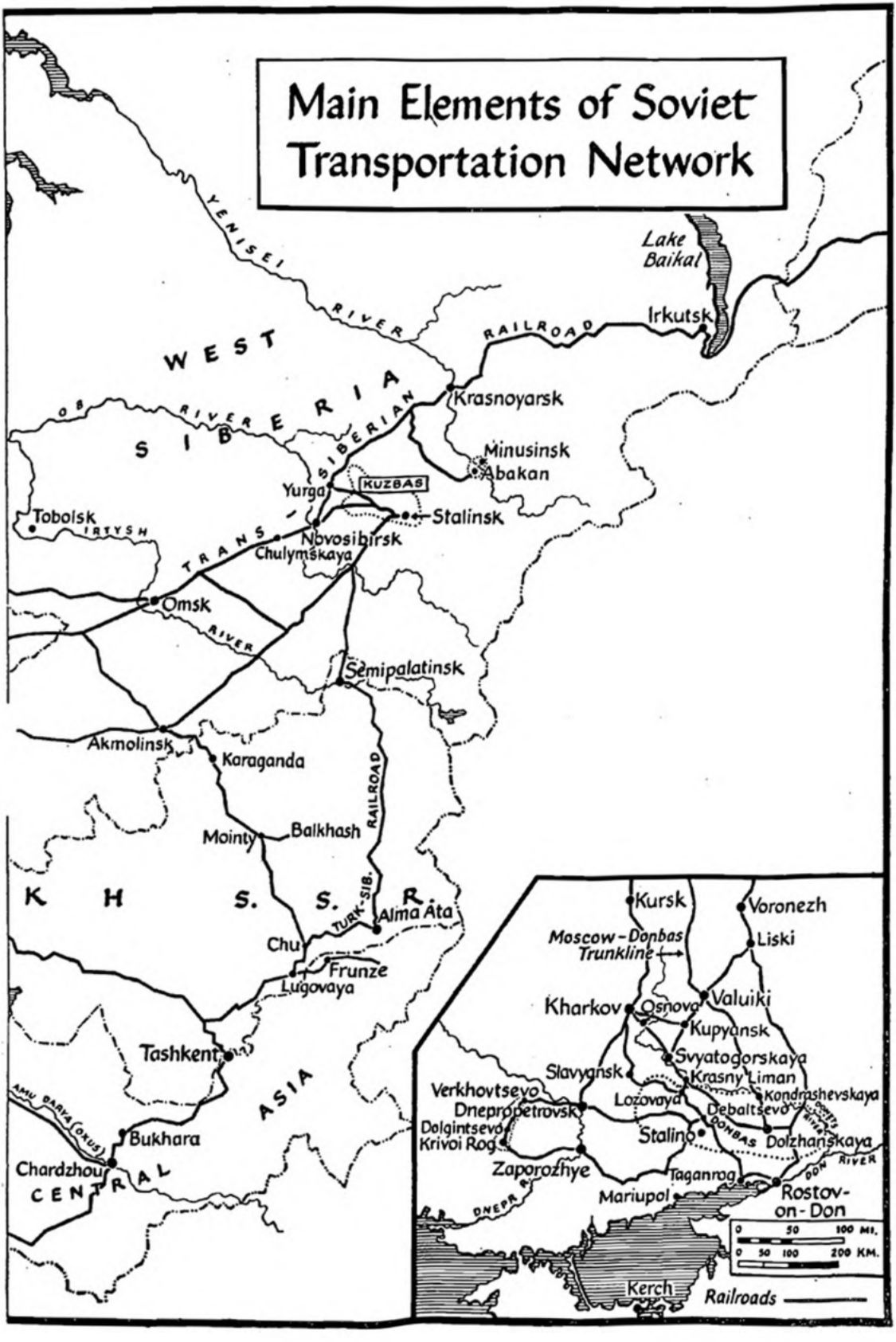
61. Smetanin, A. I. *Rezervy povyshenniia kommercheskoi skorosti gruzovykh poezdov* [Potentialities for Increasing the Commercial Speed of Freight Trains]. Moscow, 1956.
62. *Socialist Construction in the USSR.* Moscow, 1936.
63. *Sotsialisticheskii transport* [Socialist Transportation]. Monthly journal.
64. *Sotsialisticheskoe stroitel'stvo SSSR* [Socialist Construction in the USSR]. Moscow, 1934.
65. ——. Moscow, 1936.
66. *SSSR—strana sotsializma* [USSR—Country of Socialism]. Moscow, 1936.
67. *SSSR v tsifrakh* [The USSR in Figures]. Moscow, 1959.
68. *Tekhnicheskii spravochnik zheleznodorozhnika* [A Technical Handbook for Railway Men]. Moscow, 1955.
69. *Tekhnika zheleznykh dorog* [Railroad Technology]. Monthly journal.
70. *Transport i sviaz' SSSR* [Transportation and Communications in the USSR]. Moscow, 1957.
71. Tretiakov, *et al. Ocherki razvitiia zheleznodorozhnoi nauki i tekhniki* [Essays on the Development of Railroad Science and Technology]. Moscow, 1953.
72. *Tretii piatiletnii plan razvitiia narodnogo khoziaistva Soiuza SSR, 1938-1942* [Third Five Year Plan for the Development of the USSR National Economy, 1938-42]. Moscow, 1939.
73. *Trud* [Labor]. Daily newspaper. Central Council of Trade Unions.
74. *Trud v SSSR* [Labor in the USSR]. Moscow, 1936.
75. *Trudy* [Works]. The Moscow Electrical Mechanics Institute of Railroad Engineers. Volume 57. Moscow, 1949.
76. Tsaregorodtsev, V. E. (ed.). *Sbornik lektsii o peredovykh metodakh raboty zheleznodorozhnom transporte* [Collection of Lectures on Advanced Working Methods in Railroad Transportation]. Moscow, 1948.
77. *Ukazatel' zheleznodorozhnykh passazhirskikh soobshchenii leto 1959 goda* [Railroad Passenger Timetables for the Summer of 1959]. Moscow, 1959.
78. Umbliia, V. E. *Osnovy organizatsii, normirovaniia i planirovaniia truda na zheleznodorozhnom transporte* [Organization, Normsetting, and Planning of Labor for Railroad Transportation]. Moscow, 1947.
79. ——. ——. 2nd ed. Moscow, 1949.
80. *Vestnik statistiki* [Bulletin of Statistics]. Monthly journal.
81. Vikent'ev, A. *Ocherki razvitiia sovetskoi ekonomiki v chetvertoi piatiletke* [Aspects of the Development of the Soviet Economy in the Fourth Five Year Plan]. Moscow, 1952.
82. *Vodnyi transport* [Water Transportation]. Monthly journal.
83. *Vodnyi transport SSSR, 1928-1934* [Water Transportation in the USSR, 1928-34]. Moscow, 1936.
84. Vol'fson, L. Ia., *et al. Ekonomika transporta* [Economics of Transportation]. Moscow, 1941.
85. *Voprosy ekonomiki* [Problems of Economics]. Monthly journal. Academy of Sciences.

86. Voznesenskii, N. *Voennaia ekonomika SSSR v period otechestvennoi voiny* [Soviet War Economy During World War II]. Moscow, 1948.
87. *Vtoroi piatiletnii plan razvitiia narodnogo khoziaistva SSSR, 1933-1937* [The Second Five Year Plan for the Development of the USSR National Economy, 1933-37]. Volume I. Moscow, 1934.
88. Zagliadimov, D. P., *et al. Organizatsiia dvizheniia na zheleznodorozhnom transporte* [Organization of Movement of Railroad Transportation]. Moscow, 1947.
89. Zelenovskii, A. *O piatiletnem plane vosstanovleniia i razvitiia narodnogo khoziaistva SSSR na 1946-1950 gg* [On the Five Year Plan for the Restoration and Development of the USSR National Economy, 1946-50]. Moscow.
90. *Zheleznodorozhnyi transport* [Railroad Transportation]. Monthly journal.
91. Zvonkov, V. V. *Vzaimosviaz' otdelnykh vidov transporta i osnovy organizatsii smeshannykh perevozok* [The Interrelation of Different Types of Transport and Principles for Organizing Joint Shipments]. Moscow, 1953.

Non-Soviet Works

92. Acworth, Sir William. *The Railways of England.* London, 1899.
93. Barger, Harold. *The Transportation Industries: 1889-1946.* New York, National Bureau of Economic Research, 1951.
94. Behrens, C. B. A. *Merchant Shipping and the Demands of War.* London, 1955.
95. Blackman, J. H. "Measuring the Volume of Transport in the USSR" (processed). Technical Memorandum 126. Johns Hopkins Operations Research Office, Baltimore, 1951.
96. ——. *Transport Development and Locomotive Technology in the Soviet Union.* Columbia, S. C., 1957.
97. Bunnell, E. H. *Railroad Accounting and Statistics.* Chicago, 1955.
98. Burns, Arthur F., and Mitchell, Wesley C. *Measuring Business Cycles.* New York, National Bureau of Economic Research, 1946.
99. *Comparisons of the United States and Soviet Economies.* Joint Economic Committee, Congress of the United States. Washington, 1959.
100. *Current Digest of the Soviet Press.* Weekly. New York.
101. Crankshaw, Edward. *Khrushchev's Russia.* Baltimore, 1959.
102. Daggett, Stuart. *Principles of Inland Transportation.* 4th ed. New York, 1955.
103. Drucker, Peter F. *Landmarks of Tomorrow.* New York, 1959.
104. Garbutt, P. E. *The Russian Railways.* London, 1949.
105. Garthoff, Raymond L. *Soviet Military Doctrine.* Glencoe, Ill., 1953.
106. Gorter, Wytze, and Hildebrand, George H. *The Pacific Coast Maritime Shipping Industry, 1930-1948.* Berkeley, 1952.
107. Grossman, Gregory (ed.). *Value and Plan: Economic Calculation and Organization in Eastern Europe.* Berkeley, 1960.
108. Hazard, John L. *Crisis in Coastal Shipping: The Atlantic-Gulf Case.* Austin, 1955.

109. Heymann, Hans, Jr. "The Soviet Role in International Civil Aviation," *Journal of Air Law and Commerce,* summer 1958, pp. 265-280.
110. Holzman, Franklyn D. "The Soviet Ural-Kuznetsk Combine," *Quarterly Journal of Economics,* August 1957, pp. 368-405.
111. Hultgren, Thor. *American Transportation in Prosperity and Depression.* New York, National Bureau of Economic Research, 1948.
112. Hunter, Holland. "Costs, Freight Rates, and Location Decisions," *Value and Plan,* edited by G. Grossman. Berkeley, 1960.
113. ——. "How the Russians Run Railroads," *Railway Age,* August 1954.
114. ——. *Soviet Transportation Policy.* Cambridge, Mass., 1957.
115. *Intercity Ton Miles, 1939-1952.* Interstate Commerce Commission. Washington, 1954.
115a. —— *1939-1959.* Interstate Commerce Commission. Washington, 1961.
116. Kish, George. "Soviet Air Transport," *The Geographical Review,* July 1958, pp. 309-320.
117. Loree, L. F. *Railroad Freight Transportation.* New York, 1922.
118. Meyer, H. R. *Government Regulation of Railway Rates.* New York, 1905.
119. *Operating Statistics of Large Steam Railroads.* Interstate Commerce Commission. Washington. Annual.
120. *Public Roads.* Bimonthly journal.
121. *Railroad Transportation: A Statistical Record, 1921-1955.* Washington, 1956.
122. *Railway Age.* Weekly journal.
123. Sampson, Henry (ed.). *World Railways.* 1st ed. London, 1952.
124. *Seventieth Annual Report of the Interstate Commerce Commission.* Washington, 1957.
124a. *Seventy-fourth Annual Report of the Interstate Commerce Commission.* Washington, 1961.
125. *Seventy-third Annual Report of the Interstate Commerce Commission.* Washington, 1959.
126. *Sixty-sixth Annual Report on the Statistics of Railways in the United States.* Interstate Commerce Commission. Washington, 1952.
127. Splawn, W. M. W. *Government Ownership and Operation of Railroads.* New York, 1928.
128. *Statistics of Railways in the United States.* Interstate Commerce Commission. Washington. Annual.
129. Taff, Charles A. *Traffic Management: Principles and Practices.* Rev. ed. Homewood, Ill., 1959.
130. *Traffic World.* Weekly journal.
131. "Transport Economics." Monthly mimeographed bulletin of the I. C. C.
132. *Trends in Economic Growth.* Joint Economic Committee, Congress of the United States. Washington, 1955.
133. Turney, John R. "The Price of Open Gateways," *Annals of the American Academy of Political and Social Science,* September 1936.
134. *Waterborne Commerce of the United States.* U.S. Army, Board of Engineers for Rivers and Harbors. Washington. Annual.
135. White, J. L. *Analysis of Railway Operations.* 2nd ed. New York, 1946.


Main Elements of Soviet Transportation Network
YENISEI RIVER
Lake Baikal
Irkutsk
RAILROAD
WEST SIBERIA
OB RIVER
SIBERIAN
Krasnoyarsk
Minusinsk
Abakan
KUZBAS
Yurga
Stalinsk
Tobolsk
IRTYSH
TRANS
Novosibirsk
Chulymskaya
Omsk
RIVER
Semipalatinsk
Akmolinsk
Karaganda
RAILROAD
Mointy
Balkhash
K H S. S. R
TURK-SIB.
Alma Ata
Chu
Frunze
Lugovaya
Tashkent
ASIA
AMU DARYA (OXUS)
Bukhara
Chardzhou
CENTRAL
Kursk
Voronezh
Moscow-Donbas Trunkline
Liski
Kharkov
Osnova
Valuiki
Kupyansk
Svyatogorskaya
Slavyansk
Krasny Liman
Verkhovtsevo
Lozovaya
Kondrashevskaya
Dnepropetrovsk
Debaltsevo
Dolgintsevo
Krivoi Rog
Stalino
DONBAS
Dolzhanskaya
Zaporozhye
Taganrog
DON RIVER
Mariupol
Rostov-on-Don
DNEPR R.
0 50 100 MI.
0 50 100 200 KM.
Kerch
Railroads

BOUNDARY BETWEEN "WEST" AND "EAST"
Murmansk
KOLA PENINSULA
WHITE SEA
Archangel
Vorkuta
COAL FIELD
Salekhard
PECHORA
Baltic-White Sea Waterway
Lake Ladoga
NORTHERN DVINA
URAL REGION
URAL MTS.
RIVER
Tallin
Leningrad
Kotlas
Vologda
Kirov
Europeiskaya
Aziatskaya
Tavda
Tiumen
Molotov
Sverdlovsk
Sinarskaya
Kurgan
Chelyabinsk
Riga
DVINA R.
Gorky
Cheboksary
Kazan
Kanash
KAMA
Ufa
Moscow
Warsaw
Minsk
SUB-MOSCOW COALFIELD
Ryazan
Venev
Uzlovaya
Orel
Magnitogorsk
Penza
Syzran
Kuibyshev
Ekaterinovka
Orsk
Kursk
Voronezh
Kiev
UKRAINE
DNIEPER RIVER
Liski
Valuiki
Balashov
Saratov
Kharkov
Kandagach
Krivoi Rog
Odessa
DONBAS
Stalino
Zaporozhye
Mariupol
Kerchy
Rostov-on-Don
DON
VOLGA RIVER
Stalingrad
KAZAKH
Lake Baskunchak
Makat
Astrakhan
Guryev
VOLGA-DON CANAL
CRIMEA
ARAL SEA
See enlarged railroad plan right page
Tuapse
Sochi
Grozny
Makhach Kala
CASPIAN SEA
CAUCASUS MTS.
Kungrad
Takhia Tash
Batumi
Tbilisi
Baku
Krasnovodsk
SOVIET
Ashkhabad
0 50 100 200 MILES
100 0 100 500 KILOMETERS
Railroads
Samuel B. Bryant '51